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THE QUARTERLY REVIEW
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LETHAL FACTORS IN DEVELOPMENT

BY SALOME GLUECKSOHN-WAELSCH

Department of Obstetrics and Gynecology, College of Physicians and Surgeons, and Department of Zoology, Columbia University

INTRODUCTION

ANY discussion of a topic such as "lethal factors in development" will have to set itself arbitrary limits in almost every direction and in every aspect of the problems involved. The factors with which we shall be concerned are hereditary ones, transmitted according to Mendelian laws. For our purpose it is immaterial whether these factors are "genes" in the conventional sense, or whether they are chromosomal changes such as rearrangements and deficiencies. All such factors may affect processes of development by different mechanisms; for inclusion in this discussion it does not matter through which channels the interference with development operates, as long as it causes the death of the individual, i.e., has a "lethal" effect.

The number and types of lethal factors existing in plant and animal organisms are of course almost limitless. All biochemical mutations in microorganisms are, for example, lethal factors in sensu stricto, since conditions can easily be devised under which the mutation interferes with viability. It is, as a matter of fact, this lethal character which leads to the detection of the mutation. However, when it is possible to adjust the environment to the needs and requirements of an organism, a mutation may be made to lose its lethal character. As a consequence, diverse approaches may be revealed for the analysis of the lethal mechanism and of its effect both on heredity and development. This review, however, will not attempt to deal with this particular type of conditional lethal factors, but will restrict itself to cases among the higher animal organisms which show in their development the complex series of interdependent events with which embryologists deal.

The majority of lethal factors in higher organisms have so far resisted attempts to make them lose their lethal character by change of conditions of the external environment. In the case of developing amniotes the difficulties of modifying environmental conditions are of course obvious. So far, the only effective manipulation here seems to be that of genetic modifiers, which not infrequently are able to influence a lethal factor in the direction of viability.

In the broadest sense, the term "lethal" may of course be applied to all factors which prevent an organism from reproducing normally. We shall, however, not concern ourselves here with all factors lethal in the evolutionary sense, but only those lethal during embryogeny. In the case of higher organisms, lethal factors with morphological effects are more easily detected than those of physiological and biochemical character without morphological expression; the latter type may, for

technical reasons, escape detection. In any case, we shall be concerned with factors that affect processes of growth and differentiation, causing them to deviate from their normal course in drastic enough fashion to entail death of the individual before it has completed its embryonic development. The "lethal" effect of these factors is thus only the end result of interference with growth and differentiation; less severe interference may lead not to death but to deviations from normal structure and function in fully developed organ systems, i.e., to viable teratological conditions. Such effects of course differ only quantitatively from those of lethal factors; their exclusion from this discussion is thus purely arbitrary.

Some further purely arbitrary limitations must be set in this review. Material has been selected on the basis of the following criteria: as mentioned before, only higher animal organisms have been considered, and only groups in which several cases of developmental lethal factors have been described. It was deemed a prerequisite that the mechanism of hereditary transmission should have been analyzed in each case considered, and that the developmental history of the deviation should have been traced.

The analysis of lethal factors in development may contribute to numerous problems in biology. Among these are: problems of growth, cellular differentiation, developmental physiology, biochemical synthesis and intermediary metabolism, as well as those of primary gene action and mechanisms of gene effects. The suitability of lethal mutations for the study of these problems is partly a consequence of their being lethal, i.e., drastic enough to lead to death of the organism during development and thus provide obvious deviations from normal; partly it is due to the particular stage in the life-cycle during which they exert their effects, namely, when processes of biosynthesis and morphogenesis are at a peak of activity.

The mutations discussed here, as will be apparent, have as often been approached from the embryological side, with a primary interest in the mechanics of development, as from the genetic side, for an analysis of mechanisms of heredity. With the restrictions outlined above these cases have been analyzed with the following problems in mind: the mechanisms of gene action; the causal relationship of processes of development and differentiation, particularly in material not accessible to direct experimental methods; and the relationship between genes and processes of differentiation. In the case of mammals, the analysis of lethal effects of hereditary factors during development has until now been restricted almost exclusively to methods of observation. Conclusions have been based on observation and description of deviations from normal development, and on analogies with embryonic events known and thoroughly analyzed experimentally in, for example, amphibian and bird material. In the case of *Drosophila* and birds it has often been possible to approach the problem with methods of transplantation and explantation, permitting on occasion less equivocal conclusions than can be drawn from purely descriptive analysis.

LETHAL FACTORS IN THE DEVELOPMENT OF DROSOPHILA MELANOGASTER

A great number of lethal factors of different types, both spontaneous and induced, exist in *Drosophila* and have been analyzed from different aspects, e.g., mutagenicity, population genetics, cytogenetics. The question of lethal factors in the development of *Drosophila* has been thoroughly dealt with in a recent review by Hadorn (1951). In spite of the vast number of lethal mutations known in *Drosophila*, their developmental effects have been analyzed in relatively few cases, and the mechanism of lethal action has thus remained obscure in the majority of lethals. The *Drosophila* lethals can be separated into different groups according to the developmental stage at which the lethal effect of the genetic factors becomes apparent. Hadorn has thus established the following groups:

(1) *Embryonic lethals*, comprising factors whose effects lead to death of the embryo between fertilization and hatching of the larva. Some of the best analyzed representatives of this group, such as the Notch and white factors studied by Poulson, or Krüppel, investigated by Gloor, and their effects on development will be discussed in more detail below.

(2) *Larval lethals*, comprising factors whose lethal effects become apparent during larval life, i.e., in the first, second, or third instar. Those lethals in this group whose developmental effects have been analyzed in detail will be described below.

(3) *Prepupal and pupal lethals*, comprising

factors which produce their lethal effects during prepupal and pupal stages.

The lethal factors in *Drosophila* which will be discussed here have been summarized in Table 1, which lists the type and the time of the first observable abnormality, and the time or stage of death.

Embryonic lethals

Among the lethal factors affecting embryonic stages are the Notch and white deficiencies, whose effects on the development of *Drosophila* in embryonic stages have been studied and described extensively by Poulson (1940).

White deficiencies: Three deficiencies in the X-chromosome, of different sizes but all including the locus white, were shown, when homozygous, to affect organs of mesodermal and entodermal origin, while ectodermal derivatives remained unaffected. Failure of midgut differentiation becomes evident at 12 to 16 hours of development, when the midgut does not transform into a normal long convoluted tubule but remains an undifferentiated sac without any musculature. Body musculature, aorta, and fat bodies begin to be laid down but degenerate subsequently. At normal hatching time these embryos are still alive, but they do not emerge from the egg. The genetic factors missing in all three deficiencies are those in the region of 3C1-3C2.3 of the salivary chromosomes, and it is concluded by Poulson that these factors are "concerned in the development and differentiation of mesoderm and endoderm."

The developmental effects of another series of deficiencies of the X-chromosome were also studied by Poulson (1940); these are the *Notch or facet deficiencies*, whose cytological extent varies but all of which include the locus "facet." The differentiation of the embryo is affected by these deficiencies and becomes obviously abnormal at about 8 hours after oviposition. Hatching does not take place, and the embryos die shortly after normal hatching time. The different deficiencies produce identical developmental disturbances: the balance between the amount of nervous tissue and that of hypoderm to be formed as derivatives of ectoderm is severely upset in favor of nervous derivatives. As a result, there exists a hypertrophy of the nervous system, which is considerably differentiated but shows derangement of detailed structure, and in contrast hypotrophy of other ectodermal derivatives such as the hypoderm. In addition, mesoderm

TABLE 1

Lethal factors in Drosophila operating during embryonic, larval, or pupal stages

LETHAL FACTOR	TIME (AFTER OVIPOSITION) OF FIRST OBSERVABLE ABNORMALITY	TYPE OF FIRST OBSERVABLE ABNORMALITY	TIME OR STAGE OF DEATH
White deficiencies	12–16 hrs.	Failure of midgut differentiation	Soon after hatching time without having hatched
Notch facet deficiencies	8 hrs.	Hypertrophy of nervous tissue	Soon after hatching time without having hatched
Krüppel	10 hrs.	Failure of embryo to contract; defect in segmentation	Soon after hatching time without having hatched
l-7	89 hrs.	Abnormalities of gut epithelium	3rd instar, as the result of starvation
l-me	26 hrs.	Disproportionate growth retardation	3rd instar, as the result of starvation
l-gl	120 hrs.	Delay of puparium formation	Around pupation time without having pupated
l-4r	48 hrs.	Growth retardation, bloated and transparent bodies	At hatching, pupation, or metamorphosis — depending on degree of developmental arrest
crc	132 hrs.	Failure of cephalic complex to evert	At time of metamorphosis, but in puparium and unable to metamorphose

and its derivatives are abnormal and the gut remains incomplete in its development.

Poulson assumes that it is the absence of the normal facet allele which is responsible for the abnormalities observed in embryos with Notch deficiencies and that the wild-type facet allele is normally concerned with the control of germ layer separation. The primary effect of the deficiency for facet in homozygous condition is assumed to be on future mesoderm and entoderm cells, and the effect on ectodermal derivatives to be secondary, caused by the failure of the mesoderm to exert normal inductive stimuli on the ectoderm. "If this is true, it may mean that mesoderm normally plays a role in the induction of the insect nervous system, perhaps comparable in importance to that which it has in vertebrates."

The effects on development described so far may be results of the absence of chromosomal segments —although in the case of Notch similar effects on ectoderm, mesoderm, and entoderm were observed also without a visible cytological deficiency. It cannot be decided with absolute certainty whether these effects are due to the specific action of certain factors, or are just a consequence of the absence of varying amounts of chromosomal material. According to Poulson, "in all probability a single gene, which may be the normal allele of facet is the controlling agent of the processes here deranged."

The significance of these studies lies in the detailed analysis of the developmental steps deranged in this material and in the possible conclusions concerning interdependence of developmental systems which may be applied to the analysis of the mechanisms of development and differentiation of insects.

Another factor acting as a lethal during embryonic stages of *Drosophila* development is the dominant mutation "Krüppel" (Gloor, 1950) in homozygous condition. The first deviation from normal development observed in *Kr*-homozygotes is a failure of the embryo to contract and a defect in the segmental structure of the embryo at the age of 10 hours. The anlagen of the tracheae are correspondingly abnormal, and the hemoblasts, though present, are not arranged segmentally and do not fuse medially. The *Kr*-homozygous embryos survive the time of hatching by a few hours, but die without having been able to hatch. At the time of death, segmentation is still defective, only head, anal, and 3 or 4 other segments can be recognized in contrast to 12 normal segments. The tracheae are severely abnormal, and the position of the pharynx is deranged. Interestingly enough, histological differentiation of many of the topographically abnormal organ-anlagen proceeds to a considerable degree. The nervous system of the *Kr*-homozygotes shows a high degree of abnormality in the ventral ganglion complex, which is underdeveloped and abnormally differentiated.

In spite of the detailed examination and description of the pattern of abnormalities of the *Kr*-homozygotes, it has not been possible to find any clues as to the primary disturbance responsible for the defects of the embryo. Disturbance of segmentation appears to precede later abnormalities. However, it does not seem possible to construct any causal relationship between this abnormality and those observed in later stages, particularly of the nervous system.

Larval lethals

Information in very general terms only is available for many of the lethals responsible for death of the larva of *Drosophila*; here length of larval period, time of hatching, size of the larvae, and comparative stage of differentiation of imaginal discs are among the characters studied. Thus in these cases no information exists about specific effects of the lethal factors, nor about sequence of developmental events or its disturbance. However, a few lethal factors causing death in larval stages have been analyzed in some detail morphologically. One of these is the factor *l-7* located in the X-chromosome of *Drosophila* (Russell, 1940). Male larvae hemizygous for this factor die before pupation during the third instar. The immediate cause of death is starvation due to an obliteration of the lumen of the midgut. The midgut epithelium is high and irregular, instead of flat or rectangular as in normal larvae. This abnormality becomes apparent at 65 hours after hatching from the egg.

Another lethal factor leading to starvation as the immediate cause of death of the *Drosophila* larva between 3 and 7 days after deposition of the egg is *l-me* (lethal meander) (Schmid, 1949). Larvae homozygous for *l-me* die in the third instar, and a puparium is never formed. No abnormalities were detected in the embryonic stage, i.e., before hatching of the larvae. Soon after hatching, however, retardation of growth of the homozygous

larvae sets in, and growth ceases completely on the third day of development. At the age of 4 days the abnormal larvae measure only about half the length of normal larvae; the size of the individual organs of the abnormal larvae, however, is affected disproportionally. There is no uniform decrease of the growth rates of all organs, but each organ has its own specific factor by which its growth rate is decreased. At the age of 4 days pharynx and mouthhooks have attained almost normal size and are thus disproportionally large in the abnormal larvae. The tracheal trunks of a larva homozygous for *l-me* are longer than the larva itself and are therefore found to be "meandering" through the length of the body, the phenomenon to which the lethal factor owes its name "(lethal) meander." The disproportionally greater length of the tracheal trunks (4:3 at the age of 4 days) is a result of a practically normal growth rate of these organs between the ages of 3 and 5 days. They continue growing after growth of the entire body has ceased. The absolute size of midgut, Malpighian tubes, central nervous system, gonads, and tracheae is decreased in comparison with normal larvae, while the salivary glands are most retarded in their growth.

The starvation effect responsible for the death of the homozygous larva is considered to be mediated through a disturbance of protein metabolism. However, at this point of the investigations it does not seem possible to decide whether a specific disturbance of metabolism or a more general disturbance of the absorptive capacity of the intestine are at the root of the trouble.

Transplantation experiments showed that imaginal discs from larvae homozygous for *l-me* developed normally when transplanted to normal hosts. Ovaries and testes grew normally, but ovaries were unable to produce fertile eggs. Whether this latter result indicates a primary effect of *l-me* on the ovary or whether it is due to the stage of transplantation cannot be decided from these experiments. Implantation of normal ring glands into homozygous *l-me* larvae was ineffective in inducing pupation.

A comparison of rates of oxygen consumption during larval development between controls and lethals showed that the respiration rate of *l-me* homozygous larvae is below that of normal larvae. This lowered rate of oxygen consumption accompanies the changes observable morphologically, and thus adds one more interesting descriptive feature to the picture of the abnormal larvae without in any way opening possibilities for a causal analysis of the abnormalities.

Prepupal Lethals

The effects of the lethal giant (*lgl*) mutation (Gloor, 1943) become apparent at the transition between larval and pupal stages. Homozygotes appear perfectly normal during embryonic and larval stages. But when the normal larvae begin to form their puparia and prepare pupation at about 5 days after oviposition, no changes of this type occur in the *lgl* larvae: they remain larvae until at various times beginning on the 7th day puparium formation sets in. With a few exceptions all mutant larvae finally do form a puparium without, however, any further development taking place. These "pseudopupae" do not pupate and die eventually. A thorough analysis of the effects of *lgl* showed that the imaginal system was affected more than the larval system; the cells of the imaginal discs degenerate during larval life and the discs never evaginate. The retardation of growth of the ring gland is responsible for the abnormality of puparium formation.

The developmental potencies of the individual organs of the *lgl* larvae were tested in transplantation experiments (Gloor, 1943). Ovaries from *lgl* larvae transplanted to normal hosts, while not developing like normal organs, were able to progress to stages corresponding to those of early imaginal life; follicle cells, however, were abnormal and disorganized, and egg cells, if present at all, were abnormally arranged, smaller than normal, and unable to form eggs. Transplantation did not benefit the germ cells of the testes at all. The germ cells died and disintegrated in their hosts, while a certain proportion of the somatic cells developed beyond the stage they would have reached in their lethal environment and attained imaginal structure. The cells of imaginal discs and the imaginal cells of the salivary glands were unable to develop in transplants, while normal metamorphosis of *lgl* ring-glands transplanted into normal hosts was observed by M. Vogt (1947).

While the implantation of normal ring glands into lethal-giant larvae induces puparium formation, it does not "cure" the abnormalities of the imaginal discs—thus failing to give any indication of a causal relationship between hormonal abnormalities and those of the imaginal discs.

The study of the development of *lgl* larvae,

both by observation and transplantation, reveals again the peculiarities of insect development, and our relative lack of knowledge of the factors governing it and the interdependencies of the developing organ systems. It is not possible, from the results of the studies, to assign any particular organ system a decisive role in the determination of the abnormalities or to resolve the manifold effects of the *lgl* mutation into primary and secondary effects.

Pupal Lethals

The factor *l-tr*, lethal translucida, (Hadorn, 1949) in homozygous condition prohibits its carriers from reaching the imaginal stage. The exact time of death, however, varies with the genic and other environment; three sensitive phases were determined during which developmental arrest and subsequent death may occur: 1) at hatching of the larva; 2) at pupation; 3) after completion of the partial metamorphosis. Growth retardation of different degrees is reported in the different organ systems. Puparium formation is delayed by almost 24 hours in those *l-tr* larvae which survive the larval stage. Many homozygotes remain in a young pupal stage and thus survive for some time. Others undergo complete metamorphosis in the region of head and thorax while the abdomen remains in the prepupal stage, prohibiting hatching.

One of the most striking features of the translucida larvae is their bloated and transparent appearance, which is a consequence of an overproduction of hemolymph located between pupa and puparium. Although the whole larva appears thus larger than the normal one, the actual body mass is considerably below normal. It is not possible at this point of the investigations to decide whether a causative role may be assigned to the abnormal accumulation of hemolymph for the abnormalities of the different organ systems of the translucida larvae. The abnormally high amount of hemolymph might of course in turn be the result of some metabolic disturbance. Indications in favor of such a hypothesis are, for example, the results of transplantation experiments (Hadorn, 1949): imaginal discs, salivary glands, and testes of *l-tr* larvae developed normally when transplanted into normal hosts; the majority of ovary transplants, however, degenerated in the hosts. As in the case of *l-me*, discussed above, the possibility remains that the ovaries were transplanted too late, i.e., after they had been subjected to some damaging effect in the donor. The rate of oxygen consumption is reported to be higher in *l-tr* homozygous larvae than in normals, whereas it is significantly below normal in the pupae. While the significance of the increased consumption of oxygen remains obscure, the low oxygen consumption in pupal stages is of course in conformity with the general picture of developmental arrest of the pupae without being causally related to it.

In another series of experiments, Sobels (1950) obtained different results when he transplanted ovaries from larvae homozygous for *l-tr* into host larvae homozygous for *fes*. These host larvae normally develop into female flies which have rudimentary ovaries, and in consequence are sterile. With the help of genetic markers it could be shown that the donor ovaries were able to develop normally (10 out of 24 cases) and in several instances to produce fertile eggs; descendants were actually obtained from donor ovaries in 4 out of 24 cases. It is not possible to conclude from the data whether Sobels used earlier larval stages as donors of *l-tr* ovaries and whether this may account for the different outcome in the different series of experiments (6 out of 47 showing normal development in Hadorn's case, 10 out of 24 in Sobel's) or if other reasons are responsible for the different results, such as, for example, competition between donor and host ovaries.

One of the hereditary factors showing its lethal effect in late pupal stages is cryptocephal (*crc*) (Gloor, 1944). This mutant derives its name from the inability to evert its head organs, which remain hidden (crypto) in the thorax and are in consequence severely deformed. In addition to this most striking deformity, the muscles of the thorax are reduced in size. Among other abnormalities, not obviously connected with those just described, are those of extremities and bristles, which are shorter than normal. While head and thorax show imaginal differentiation, the abdomen frequently remains in the condition of pupal stages. All grades of differentiation between the imaginal and pupal conditions may be found in *crc* mutants. Death of the pupae occurs in the puparium; they never hatch. Implantation of normal ring glands remains without beneficial effect. The reciprocal experiment, namely, a test of developmental potencies of ring glands from *crc* larvae by transplantation into normal hosts, has not been reported.

The *crc* mutation is particularly susceptible to

the effect of modifiers. Depending on the residual genotype, all cryptocephal homozygotes may either die in the puparium or develop into normal adult flies. External factors also are able to influence the expressivity of "cryptocephal": lethality increases with increasing breeding temperature. Finally, sex has an effect on the severity of the cryptocephal condition: females seem to be more severely affected than males.

The difficulty of analyzing the manifold effects of these *Drosophila* lethals and fitting them into some kind of developmental scheme is of course closely connected with the peculiarities of insect development and our relative ignorance of the mechanisms governing it. Particularly little is known about the interrelationships and interdependencies of the developmental systems of insects. Experimental studies of insect developmental mechanics have demonstrated the existence of a differentiation center and of progressive determination in the egg of the dragonfly (archiptera); on the other hand, determination and localization of organ-forming areas have been found to be far advanced in the dipteran egg. Thus, in the case of *Drosophila*, we seem to be dealing with a type of highly mosaic development with very early determination. This fact must be taken into account in the design of methods for the study of developmental effects of lethal factors in this organism. Such methods must of course differ from those used in the analysis of organisms with more regulative development and relatively late determination. At present, only patchwork is being done in the analysis of lethal factors during the development of *Drosophila*. Mutations are analyzed and their developmental effects noted down; they do not fit into any pattern yet. A pattern may become established after many more data have been filled in; or it may be there all the time but become apparent only after more knowledge has been obtained about normal insect development.

PHENOCOPIES OF LETHAL FACTORS IN DROSOPHILA

An attempt has been made to gain some more insight into the mechanisms of lethal gene effects in these organisms by the production and study of phenocopies. Such phenocopies of genetically abnormal individuals were obtained by the use of various agents.

l-me Phenocopies

Effects similar morphologically though different physiologically from those of the lethal mutation *l-me* in homozygous condition could be reproduced by starving normal larvae at 2 and 2½ days after oviposition (Schmid, 1949). These phenocopies resembled the normally fed, but genetically abnormal larvae in great morphological detail; they differed, however, from these by their ability to rebuild from either sugar, fat, or casein their fat-body after it had been depleted of fat by starvation. In contrast, genetically abnormal starved larvae could utilize only fat and sugar, but were unable to rebuild the fat-body when fed casein alone. In the absence of more exact metabolic studies, e.g., with the help of isotope tracers, the latter experiments cannot help to decide whether a specific disturbance of protein metabolism is created by the effect of the mutation *l-me*, or whether the inability to utilize protein is a result of the generally weakened physiological condition of the *l-me* larva aggravated by starvation.

crc Phenocopies

The entire complex of abnormalities of *crc* pupae (failure of head organs to evert, and shortening of legs, wings, and bristles) could be copied by subjecting normal prepupae to hot or cold temperature shocks (Gloor, 1944). On the basis of the identity of abnormalities in genotypically abnormal (*crc*/*crc*) and in phenocopic pupae, Gloor has assumed identity of developmental phenomena leading to the abnormalities observed. The temperature shock in the phenocopies is given in the prepupal stage; it would therefore be interesting to transplant parts of the *crc* homozygous larvae before this stage in order to test their developmental potencies and to ascertain that they are really normal *prior* to the "sensitive period."

In general, the similarity between genotypic and phenocopic abnormalities suggests possible similarities of developmental events, though probably in relatively late stages only. Earlier stages may differ in the details of developmental potencies. Also, of course, such similarity does not give any indication about the nature of primary factors responsible for the abnormalities of genotypically abnormal individuals or of phenocopies. The interpretation of the results obtained with phenocopies suffers from the same difficulties as those encountered in the analytical studies of the effects

of lethal factors on *Drosophila* development, namely, from the lack of knowledge of the normal developmental mechanisms in operation, and of the normal interrelationships and interdependencies of the developmental systems.

LETHAL FACTORS IN VERTEBRATES

The causal analysis of the effects of lethal factors in development becomes slightly less frustrating than it is in *Drosophila*—at least at this stage of the investigations—when we proceed to the discussion of vertebrate organisms as experimental material.

Amphibia

The existence of embryonic lethal factors in the Amphibia has been inferred from the variations in survival of haploid larvae of *Triturus* (cf. Moore, 1950). Such variations have been ascribed to different genetic constitutions of the larvae. If lethal factors with deleterious effects on development are distributed throughout amphibian populations, their effects will become apparent in haploid embryos by their inability to survive. However, no genetic or specific developmental studies of such factors have been performed.

Chick

A number of lethal factors have been discovered in the chick, and their genetic behavior as well as developmental effects were studied in a good proportion of cases. The development of the normal chick embryo, of course, has been well analyzed with the help of both descriptive and experimental methods, and many of the mechanisms operating during development are known. In contrast to *Drosophila*, where three clearly distinct phases of development (embryonic, larval, pupal) precede hatching of the imago and where the interrelationships between these developmental phases as well as between each phase and the adult phase are largely unknown, the transition of one stage of development to the next is more gradual and more fluid in the vertebrate embryo. Correlated with this is a greater knowledge of the interrelationships between succeeding developmental stages and between embryonic and adult organ systems. Thus in the chick there seems, at least at present, to be a better chance of analyzing the details of when and how a mutational effect strikes developmental processes. Landauer (1951) lists 16 lethal mutations in the chick where morphological details of embryonic abnormalities responsible for death of the chicks before hatching have been described. The developmental aspects of the abnormalities have been considered and analyzed in several of these lethal mutants, and it will be mainly these that will be dealt with.

Stickiness

In the chick, some of the genetic factors responsible for death of the mutants permit development up to hatching time, and death is the result of a severe abnormality interfering with the mechanism of hatching. Such a factor, for example, is "stickiness" (Byerly and Jull, 1932), in which the inability of the full-term embryo to hatch is a result of the complete softness of the bones of the sticky embryo, including those of the beak. These embryos at the time of hatching are immersed in amniotic and allantoic fluids which have neither been swallowed nor absorbed and have become viscous and sticky. Apparently, a defect in the calcium metabolism of the sticky embryos is correlated with their inability to utilize calcium from the shell, while the source of the disturbed water metabolism, expressed in widespread edemata and the persistence of amniotic and allantoic fluids, remains unknown. So far, no connection has been established between these two disturbances.

Abnormal Upper Mandible

Another factor whose effects permit survival of the embryo to the time of hatching but eventually prohibit actual hatching was reported by Asmundson (1936) and called "abnormal upper mandible." This lethal factor produces abnormal maxillae and premaxillae. In addition, slight effects on other facial bones were reported. The weakness of the beak makes hatching of the homozygotes impossible. In this case even more than in the one discussed before, a defect interfering with the mechanics of hatching carries the immediate responsibility for death of the homozygote, while the developmental disturbances underlying this defect are unknown.

Short Upper Beak

A mutation which only in the absence of certain modifiers has a completely lethal effect is "short upper beak." The most obvious abnormalities of the embryos are shortening of the beak and the long bones of the extremities. The fact that some

homozygotes with extremely short upper beaks are able to hatch seems to indicate, however, that death of the rest of the homozygotes cannot be attributed to a block of the hatching mechanism. Developmental studies show that toward the end of incubation development is markedly retarded. Landauer (1941) assumed that general developmental processes are affected by the genic alteration and that death of the homozygotes is due to general developmental disturbances. He (1946) was later able to demonstrate that modifiers play an important role in the expression of this mutation; it was possible to select simultaneously toward higher hatchability, decreasing beak abnormality, and normal length of long bones, a fact which indicates that a common mechanism underlies the different disturbances.

Talpid

Cole (1942) has described a most interesting lethal factor in the chick, one producing striking developmental disturbances in relatively early stages of development. "Talpid"—so named because of the molelike (talpa = mole) appearance of the extremities of these embryos—reduces the proximal bones of the extremities in length, while extreme polydactyly occurs distally. Additional abnormalities include shortening of the vertebral column, ectopia of the viscera, extensive subcutaneous edema, deficient feather development, and face malformations. The first deviations from normal development may be recognized at 4 days of incubation in shape abnormalities of the limb buds. Death of the homozygous embryos generally occurs at 8 to 10 days of incubation; occasional survival beyond this stage is reported, in one case up to 17 days of incubation. No causal analysis of the physiology of the "talpid" effect has been attempted; it is therefore not possible to correlate the different effects of the lethal factor and to obtain a picture of the developmental mechanisms disturbed. From the description of the abnormalities it appears that hardly one organ system has been left undamaged by the effects of "talpid" and it seems likely that this lethal factor interferes with some fundamental physiological process.

"Lethal condition affecting both mandibles"

The inability to hatch of chicks homozygous for a certain autosomal recessive lethal affecting both mandibles (Marble, Harper, and Hammers, 1944) is due to disturbances of head development in early stages of incubation. This abnormality may be detected at 9 days of incubation. In addition to abnormalities of maxillae and mandible—the latter usually missing entirely—cerebral hernia and various facial distortions are found in homozygous embryos. It is not certain whether the inability to hatch is responsible for the death of embryos homozygous for this mutation, since removal from the shell at the time of hatching does not enable the chicks to survive.

Diplopodia

While in the mutation just described the morphological manifestations of its abnormal effects are restricted to the head, another recessive lethal mutation, diplopodia (Taylor and Gunns, 1947) produces abnormalities of both head and extremities. Legs and wings exhibit polydactyly, shortening, and dystrophy of the long bones leading to abnormal curvatures, and in the beak the maxilla is shortened markedly. While these deformities might well be responsible for the failure to hatch of such homozygous chicks and consequently for their death, additional effects of the mutation without obvious morphological manifestations must exist: for the majority of the very few chicks which did hatch were unable to survive, and one that lived was abnormally small and not able to lay normal eggs.

Crooked Neck Dwarf

A mutation with far-reaching general effects manifested in various morphological abnormalities and leading to the death of homozygous embryos is "crooked neck dwarf" (Asmundson, 1945). "Crooked neck dwarfs" die just before or at the time of hatching. Up to the age of about 12 days of incubation their weight is normal, but at that age their growth rate slows down markedly, coming practically to a halt at 16 days of incubation, whereas normally weight approximately doubles between 16 and 20 days of incubation. In addition to the general dwarfing, this mutation specifically produces abnormalities of the upper beak, neck, sternum, and long bones of the leg; furthermore, the breast muscles are absent or reduced, and the leg muscles underdeveloped. The presence of edema in dwarf embryos of 11 to 13 days of incubation suggests the existence of a general physiological disturbance in these homozygotes. Death occurs just before hatching, when

the embryos are unable to undergo normal movements and to pip the shell. While the inability to hatch appears to be the ultimate reason for death, the distribution of the effects of the mutation suggests a general disturbance interfering severely with fundamental physiological phenomena. Pituitary deficiency is suggested as a possible underlying cause.

Cornish Lethal

Skeletal development is severely affected in the presence of the dominant mutation "Cornish Lethal" in two doses (Landauer, 1935, 1939a). Such homozygous embryos show disproportionate dwarfism. While the extremities are shortened considerably, general body size is relatively normal and the head is short and broad with bulging eyes. Like most of the lethal factors in the chick discussed so far, the Cornish lethal embryos die just before hatching or are alive but unable to hatch at hatching time. Relative and absolute increase of weight of spleen and heart of homozygotes, as compared with normals, is explained as a consequence of the deficiency of blood-forming tissue due to the abnormality of the long bones. This deficiency is compensated by a greater activity of other haematopoietic centers. The actual nature of the effect of Cornish lethal is not known, any more than in the case of the mutations discussed before, nor can it be decided whether the inability to hatch carries the entire responsibility for the death of the homozygotes.

Creeper

The last two lethal factors in the chick to be discussed here are those whose developmental effects have been investigated most thoroughly.

Various approaches have been used for the purpose of analyzing the most interesting effects of Creeper, a dominant mutation in the chick, lethal in homozygous condition, and in some respects resembling "Cornish lethal" but genetically distinct from it; animals heterozygous for the Creeper mutation are characterized by their short extremities (Dunn and Landauer, 1926). Homozygous embryos generally die toward the end of the third day of incubation, and only a small number survives to later stages. The survivors are severely malformed. They show phocomelia-like defects of the extremities, defects leading to absence of bone marrow and to the development of acute anemia. Furthermore, these surviving homozygous Creeper embryos have head and eye abnormalities, such as microphthalmia, coloboma, etc., and are considerably smaller than normal. They die before hatching. Since the percentage of homozygous Creeper embryos surviving the first critical phase (3 to 4 days of incubation) is very small, an extended and extremely careful study was required for the detailed description and analysis of their abnormalities (Landauer, 1932). One of the most obvious effects in homozygotes is the length of long bones: these are extremely shortened although a certain amount of growth continues up to the latest stages. The eyes, which remain only about one-third of normal size, do not show any increase in weight after 11 days of incubation. The weight of liver is reduced in relation to that of the whole body; in contrast to this the relative weights of spleen and heart show an increase (over those of normals) beginning at 11 days of incubation and continuing thereafter (Landauer, 1939b). While even the absolute weight of the spleen of homozygous Creeper embryos surpasses that of normal embryos, only the relative weight of the heart is increased. A compensatory mechanism seems to be responsible for this weight increase: since the long bones of Creeper homozygous embryos do not form any marrow, acute anemia resulting from the absence of the main source of red blood cells leads to a functional hypertrophy of spleen and heart.

While phocomelia is the most prominent feature of the class of homozygotes which survive to late stages of embryogeny, abnormalities of the extremities can obviously not make their appearance in the homozygotes dying at about 3 days of incubation. In these, microcephaly is one of the striking features. Histologically, thinning of the brain wall, cellular degeneration in the nervous system, deficiency of head mesenchyme have been described (Landauer, 1932; Rudnick and Hamburger, 1940). The left side of the growing head seems to be more retarded than the right, resulting in more severe abnormalities of left eyes and otocysts. The abnormalities of the heart of these early dying homozygotes are not uniform, varying from severe retardation in form to enlargement in size as compared with normal stages. Most organ systems show thinning of tissues. The extraembryonic circulation as well as that inside the embryo is highly abnormal; normal vitelline circulation fails to develop, while clotting, extravasation, and distention of fluid spaces occur inside the embryo.

In comparing the description of late homozygous Creeper embryos with that of embryos dying in early stages, abnormalities of the vascular system, though of different kind and degree, appear to be a feature common to both. It is difficult to determine, however, whether on the one hand absence of bone marrow and resulting anemia, as in late homozygotes, and on the other hand underdevelopment of extraembryonic circulation and internal extravasation, as in the early homozygotes, might really be different expressions of the same original disturbance caused by the Creeper factor in homozygous condition. It has been shown that the relative frequency of early- and late-dying *Cr* homozygotes depends on the residual genotype and is to a large extent determined by genetic modifiers.

Explantation experiments (David, 1936) showed that heart fragments of *CpCp* embryos grew at a rate inferior to that of the same tissues taken from normal embryos, while explants from other regions of the embryos showed practically normal growth. The capacity to differentiate seems unimpaired in all tissues with the exception of limb cartilage, which did not show normal differentiation in chorioallantoic grafts. David concluded from his experiments that the *Cp* factor in homozygous condition does not act as a cell lethal making all tissues inviable. He demonstrated that different embryonic tissues showed different degrees of growth restriction, the heart being most seriously retarded, and David suspected the resulting disturbance of developmental and growth correlations to be the cause of death of *CpCp* embryos. It is not possible to decide how much of the growth restriction of the different tissues observed by David might be due to the effects of the experimental environment rather than to inherent factors. The failure of limb cartilage to show normal differentiation in the chorioallantoic grafts was ascribed to the general growth retardation in *CpCp* embryos, a retardation affecting presumptive limb cartilage preferentially in its differentiation capacities. David has assumed that differences in time of death of early and late Creeper lethals are due to variations in the degree of disturbance of developmental correlations.

Hamburger (1941) was able to show that primordia of early-dying *CpCp* embryos were able to undergo a considerable amount of differentiation when transplanted into the coelom of normal chick hosts. Leg and wing primordia from *CpCp* embryos of 49 to 74 hours of incubation (19–30 somites) developed into healthy legs and wings of the phocomelic type showing the typical morphological, histological, and growth abnormalities. The presence in *CpCp* embryos of growth and histogenetic potencies shown by David was thus confirmed, and added to it was proof of the presence of a high degree of morphogenetic potencies. This experiment also demonstrated that early- and late-dying *CpCp* embryos possessed similar developmental potencies, at least insofar as the limb skeleton is concerned.

The primary responsibility for the early death of *CpCp* embryos (at 4 days) was ascribed to abnormalities of the vascular system by Cairns (1941), who was able to produce "phenocopies" of Creeper homozygotes by blocking the vitelline arteries in normal chick embryos of 44 hours incubation. Until, however, phocomelia-like development of limbs transplanted from such "phenocopies" is reported, it is doubtful whether one is permitted to conclude that the vascular abnormalities play a causal role in the syndrome of abnormalities of *CpCp* embryos.

Rudnick (1945) approached the question of whether the abnormalities of the vascular system of *CpCp* embryos were really the primary cause for the phocomelic condition of the limbs of older *CpCp* embryos by transplanting limb-forming material from *CpCp* embryos prior to the appearance of vascular abnormalities and prior actually to the appearance of any vascularity in the blastoderm. Limbs developing from this material showed typical features of phocomelic limbs. Thus, proof has been provided to show that the determination of phocomelic character takes place before vascularization sets in and that abnormal vascularization cannot be the primary cause of the abnormalities and death of the *CpCp* embryos. These experiments also show that even at stages about 24 hours earlier than those which Hamburger used, i.e., at the stage of 6 to 9 somites, limb primordia from *CpCp* embryos possess the morphogenetic and histogenetic potencies of phocomelic limbs.

The independence of vascular and skeletal abnormalities is also indicated by conditions in the Creeper heterozygotes. These are characterized by chondrodystrophy of the extremities that traces back to abnormalities of the cartilages at 7 days of incubation, while no obvious vascular abnormalities of any kind exist in these heterozygotes.

Transplantation experiments of eye anlagen between normal and *CpCp* embryos (Gayer and Hamburger, 1943) were undertaken in order to

determine whether the abnormalities of the eyes of *CpCp* embryos were due to local gene action in the eye primordia or to abnormalities of structures or factors extrinsic to the eye.

In these experiments it was found that eye primordia from *CpCp* embryos differentiated into normal eyes when transplanted orthotopically to normal hosts. However, eye primordia from *CpCp* as well as from normal donors differentiated into typically abnormal *CpCp* eyes when transplanted to the flank of normal embryos, i.e., in heterotopic position. Thus, differentiation of *CpCp* as well as of normal eye primordia depends on the nature of the environment in which the eyes undergo differentiation; the normal head provides an adequate environment in contrast to the flank. Gayer and Hamburger concluded from their results that the deficiencies of abnormal *CpCp* eyes are not due to "local gene action" in the eye primordia of *CpCp* embryos, but that the primary action of *Cp* is on structures extrinsic to the eye. Landauer (1944) has challenged the absolute validity of these conclusions and considers them only one possible explanation of the facts. In support of this argument he subjected the experimental results obtained by Gayer and Hamburger to the assumption that an essential substance might be lacking in *all* tissues of *CpCp* embryos as a result of the action of *Cp* in two doses. This substance would then be supplied by the cells and tissues of the normal environment to which the deficient *CpCp* eye primordia were transplanted, and would result in the differentiation of normal eyes.

Since none of the results obtained by Gayer and Hamburger are in contradiction to such an assumption, Landauer concluded that at this point it is not possible to decide whether the abnormalities of the eyes of *CpCp* embryos are actually due to "local gene action" or to an effect on the eye of extrinsic factors, or to a combination of the two.

While thus the immediate cause of death of *CpCp* embryos has been analyzed and found to lie in vascular abnormalities in the early lethals and acute anemia in the phocomelics, the developmental mechanisms responsible for the abnormalities of extremities and head as the result of the effect of the *Cp* factor in two doses remain obscure.

Wingless

The last lethal mutation in birds to be discussed here is "wingless," a name which does not adequately describe the numerous effects of this recessive mutation on organ systems other than the extremities. Embryos homozygous for "wingless" fail to hatch, although many of them survive to the end of the incubation period. They lack lungs, airsacs, and kidneys, and have an abnormal down plumage.

The embryology of this interesting mutation was studied by Zwilling (1949), who observed the formation of normal wing buds in early stages, but found that subsequently the apical ectodermal ridge failed to form, so as to result in absence of the wing or parts of it. The significance of the apical ridge material in normal wing development had been demonstrated previously.

The absence of any trace of ureteric buds in wingless embryos and the subsequent absence of both metanephric kidneys is in agreement also with experimental results on normal chick embryos which showed the dependence of the metanephric kidney on the ureteric bud for its development and differentiation. Zwilling was unable to decide on the basis of his studies if failure of the entodermal lung bud or its mesodermal environment or even other factors are responsible for the failure of lungs to develop.

The possible significance of the entobronchial bud for normal lung development has been pointed out by Rudnick (1933), who also stressed the simultaneous importance of the mesodermal environment. Since an epithelial layer is involved in the formation of wings, kidneys (ureter), and lungs, Zwilling has suggested this as a possible connecting link between the developmental effects of wingless on the different and apparently unrelated structures. On the other hand, there are a number of other perfectly normal epithelial structures in the same embryos. Waters and Bywaters (1943), who first described this mutation, thought of some common "hormonic" control underlying the formation of abnormalities. Although no proof exists for such an assumption, it is interesting in this connection that Zwilling did observe general growth retardation in wingless embryos.

The analysis of the wingless mutation is an excellent example of the way in which methods and concepts of experimental embryology may be combined with methods of study of the effects of lethal mutations, for the purpose of elucidating possible mechanisms underlying the abnormalities leading ultimately to death of the affected embryos.

Mammals

The study of the effects of lethal factors on development is helped greatly in the case of amphibians and birds by the relatively high degree of knowledge of the developmental mechanics of these organisms; relying on this knowledge it is possible to attempt an analysis of the developmental mechanisms disturbed in the case of the individual lethals. The situation is reversed when we consider the study of lethal factors in the development of mammals. Here we not only are almost totally ignorant of the developmental mechanisms operating in normal development—except for certain analogies with lower vertebrates—but we actually try to utilize the deleterious effects of the lethal factors in an attempt to gain insight into the normal course of events. Adding the results of studies of lethal effects to analogies with lower vertebrates, it has been possible to obtain some knowledge about developmental mechanisms operating in mammalian embryos.

As pointed out in the introduction, it is necessary for the purpose of this review to limit quite arbitrarily the definition of the term "lethal." This will have to be remembered again when we begin to discuss lethal factors in mammalian development. Out of the vast number of lethal factors existing in this group only those hereditary factors will be chosen for discussion whose deleterious effects on development leading to death of the affected individual at or before birth have been examined to some extent.

Guinea Pigs

A "summary of lethal characters in animals and man" was published by Eaton in 1937, and lists a vast number of abnormalities of hereditary nature. This summary includes the lethal factors leading to the death of individual mammals before birth, at birth, or after birth. Discussions of the developmental mechanisms concerned in the effects of the cases listed are quite limited in the original papers, with the exception of the interesting discussion of head abnormalities in guinea pigs by Wright and Wagner (1934). The hereditary transmission of the factors responsible for these head abnormalities is not simple; apparently more than one gene is involved. In addition, non-genetic environmental factors are instrumental in producing the abnormalities. All these factors apparently act by exerting inhibiting effects on developmentally active regions of the embryos, either directly or by way of increasing the susceptibility of the regions involved. The centers of effect seem to be related to derivatives of the prechordal plate, and the abnormalities might thus be a result of disturbances of head organizer relationships in the young embryo—if indeed one may be permitted to compare in more than broad outlines conditions in a mammal such as the guinea pig with those analyzed in amphibian embryos with the help of experimental methods.

Mice

The most extensively analyzed group of embryonic lethals in mammals is found in mice, a fact which is not surprising since the mouse is the mammal most thoroughly investigated genetically. As a matter of fact, the first detailed investigation of any lethal factor in the history of genetics was done in the mouse.

Yellow. The "yellow lethal" was discovered by Cuénot (1905). Cuénot noticed that yellow mice when bred together did not breed true for yellow and thus could not be homozygous for the yellow mutation, but on the other hand did not produce the three yellow: 1 non-yellow ratio expected if they were heterozygous for a dominant mutation. Actually, all yellow mice when mated inter se gave offspring in a ratio of 2 yellow: 1 non-yellow, and Cuénot assumed that the absence of homozygous yellow offspring was due to the inability of a yellow-bearing egg to be fertilized by a yellow-bearing sperm. That the absence of yellow homozygotes was not due to incompatibility of yellow-bearing eggs and sperms, but to interference with development and consequent loss of the yellow homozygous class was postulated by Castle and Little (1910). The actual demonstration of the lethal effect of the yellow factor was accomplished by Kirkham (1919), after Ibsen and Steigleder (1917) and Little (1919) had reported findings of remnants of embryos which they assumed to have been yellow homozygotes. While Kirkham was correct in his general interpretations, the details of his study of embryos homozygous for "yellow" could not be confirmed by Robertson (1942), who made an extensive experimental analysis of the effects of this lethal factor. In contrast to Kirkham's reported abnormalities of early cleavage stages, Robertson found the first abnormalities of homozygous yellow embryos to occur at the time of implantation in the uterus. At this time the yellow embryo be-

comes lodged in a decidual crypt, and the change of the uterine epithelium from columnar to cuboidal as well as the proliferation of the subepithelial uterine connective tissue proceed in normal fashion. But while normally the cuboidal epithelial cells disappear, this does not occur at the implantation site of the yellow homozygote, and further development of the site does not take place. According to Robertson, the trophectoderm of the homozygous yellow blastocyst collapses upon contact with the uterine epithelium; it degenerates, the blastocyst cavity of the abnormal embryo disappears, and the cells of the remaining inner cell mass soon become abnormal and degenerate without differentiating any further. Robertson assumed that disturbance of the implantation mechanism is responsible for failure of the embryo to continue further development. Such a disturbance would center around the enzyme which is supposed to be secreted by the blastocyst in order to prepare the uterine epithelium for implantation. If this interpretation is correct, a direct effect of the "yellow" gene on the implantation enzyme of the blastocyst would be responsible for the lethal action of this genetic factor. More insight into this problem was obtained when Robertson transplanted ovaries from females heterozygous for yellow into agouti females; these agouti females with "yellow" ovaries were then bred to heterozygous yellow males, and the resulting homozygous yellow embryos were studied in their new environment, i.e., the uterus of an agouti female. These embryos showed considerably more development than was observed in yellow mothers, and the uterine epithelium of the mother was completely eroded at the implantation site of "yellow" embryos, as is the case normally. Since on the basis of the enzyme theory of implantation this erosion must be the result of a normal enzymic activity, the original hypothesis assuming an effect of the yellow gene on the implantation enzyme should really be revised. The yellow homozygous embryo apparently is unable to continue normal development even if implantation has been accomplished successfully. It seems as though perhaps other aspects of growth and differentiation in addition to the implantation mechanism may be disturbed by this lethal factor.

Modifiers and Lethal Effects. In this connection a few words should be said about the effect the environment may have on the expressivity of any lethal factor. The lethality of such factors is of course always an expression of their effect in a particular environment. Modification of this effect both in a positive direction, with the result of lessening it, and in a negative direction, with the result of making it more deleterious, may result from changes of the environment; to this end external means as well as genetic modifiers may be effective. The dependence of the effect of lethal factors upon the external and internal environment is of course a feature of the action of genes in general, none of which produce their effects in vacuo but all of which are highly dependent for their expression on the rest of the total genotype as well as the environmental conditions in which they find themselves. If we thus speak of "lethal factors," we must always keep in mind that such factors may lose their lethal character, or at least modify it, in an environment different from that in which they were found originally.

Danforth Short. One such factor—subject to a high degree of modification by genetic modifiers—is Danforth Short (*Sd*), a dominant mutation in mice with lethal effects when homozygous. Such homozygotes die shortly after birth; they are tailless, and have an imperforate anus (Gluecksohn-Schoenheimer, 1943). In the stock in which this mutation was first described, both kidneys were missing regularly in homozygotes; their death at time of birth was thus easily explained by the absence of kidneys and by the imperforate anus. When the original mutation was outcrossed to different stocks, it was found that the phenotype of *Sd* heterozygotes and homozygotes was easily modified by the genetic background: while heterozygotes (*Sd*/+), which originally had shown some degree of kidney abnormalities in the vast majority of cases, had perfectly normal kidneys on certain genetic backgrounds, homozygotes improved in the same direction and developed kidneys which were smaller than normal but which would probably have permitted survival of the affected individual, if the imperforate anus had not persisted as a constant symptom (Dunn and Gluecksohn-Schoenheimer, 1945). However, there is every reason to assume that it should be possible to make a viable factor out of the "lethal" *Sd* by searching for the appropriate genetic environment in which modifiers could have an improving effect also on anal development in *Sd* homozygotes.

It is thus important to remember that lethal factors may be subject to modification to the

extent of losing their lethal character, and that a consideration of lethal characters as attempted in this review necessarily treats these factors in a relative state, i.e., relative to the rest of the genotype, and to the environment.

The analysis of the embryological steps preceding the abnormalities of the urogenital system in *Sd*-homozygotes led to the conclusion that the metanephros of mammals depends for its differentiation on an inductive stimulus given off by the tip of the ureter (Gluecksohn-Schoenheimer, 1945). A similar dependency had been found to exist in chicks, where transplantation experiments were used in the analysis of the developmental mechanics of the metanephros. While the metanephrogenic blastema appeared normal in *Sd*-homozygotes, the ureter remained small and underdeveloped. Its tip either did not branch at all into cranial and caudal pole tubules or only to a very slight extent. The metanephrogenic blastema failed to differentiate normal kidney elements in the absence of the ureter reaching it. Studies of the development of the urogenital system of embryos heterozygous for *Sd* confirmed the suspected correlation between ureter development and metanephric differentiation. In heterozygotes a strong correlation between the degree of branching of the ureter tip and that of metanephric differentiation around it was found to exist, in addition to a complete absence of kidney differentiation whenever the ureter did not reach the metanephrogenic blastema. Although final proof for the inductive relationship between ureter and metanephros must come from transplantation or explantation experiments, such a relationship is strongly indicated by the analysis of the developmental effects of *Sd* and receives further support from the existence of similar conditions in the chick.

Mutations in Chromosome IX of the Mouse. Perhaps the most interesting group of lethal factors in mice—certainly from the point of view of the experimental embryologist—is the group of mutations located in the ninth linkage group. The developmental effects of these lethals have been investigated in considerable detail and have been reviewed most recently in *Advances in Genetics, 4* (Gluecksohn-Waelsch, 1951). A close relationship between these factors, both genetically and developmentally, has been demonstrated (cf. Dunn and Gluecksohn-Waelsch, 1953).

While the number of mutations belonging to this group amounts at present to 14, only those 10 will be discussed here which in homozygous condition have a lethal effect during development; of these, two are recurrences of two previously known mutations, with identical effects, and therefore will not be listed separately. Those remaining are three dominants: ***T*** = Brachyury, ***Ki*** = Kink, both always lethal when homozygous, and ***Fu*** = Fused, only conditionally lethal; and 5 recessives: t^6, t^1, t^4, t^9, t^{12}, all of them lethal when homozygous and interacting with ***T*** to give taillessness when heterozygous.

Brachyury (***T***). The effect of ***T*** in two doses on development was analyzed and described by Chesley (1935). Up to the age of 8 days after fertilization no abnormalities are found in ***T/T*** embryos externally; shortly thereafter irregularities of neural folds and somites appear until at about 10 days the following abnormalities characterize the ***T/T*** embryo: the posterior region of the body is missing, the embryo ends somewhere between forelimb and hindlimb buds; only a few remnants of somites are present; the neural tube is crooked and twisted. Histological differentiation seems to be disturbed most severely in the notochord. While notochord-forming material appears normal in early stages, its differentiation does not proceed normally, and only remnants of notochord are found in intermediate stages, until at the time of death not even traces of notochord are present. The histological investigation particularly seems to point to the notochord as the most severely affected and also as the primarily abnormal structure in ***T/T*** embryos, while interdependencies of the different organ systems during development can account for abnormalities of the nervous tube and other axial structures.

The investigation of the developmental effects of ***T*** thus provides strong evidence to indicate an extension to mammalian development of the role which the notochord has been found to play in the development of other vertebrates. On the other hand, it could be shown that death of the ***T***-homozygote at the particular stage of 10 days after fertilization is—if at all—only indirectly connected with the abnormalities of notochord and nervous system: these embryos die because of the complete absence of umbilical connection with the mother (Gluecksohn-Schoenheimer, 1944). At the age of 10 days they would normally become dependent on the placental circulation for their nutritional and respiratory requirements, and their

death at that particular time is adequately explained by the absence of umbilical circulation. Severe abnormalities of the allantois preventing the umbilical vessels from developing normally were observed in earlier stages.

Kink (*Ki*). The second dominant mutation in this group—Kink, "*Ki*"—was found also to affect the notochord-mesoderm system of the early embryo, though in a different way and probably at a different time than *T* (Gluecksohn-Schoenheimer, 1949a). Embryos homozygous for *Ki* were found to have duplications of different types and degrees. All these embryos showed either complete or partial duplication of the entire embryonic axis, duplications of individual organs or parts of them, while occasionally the only symptom of a duplication was the presence of a lump of tissue resembling a "Bauchstück" in the sense of Spemann. Although there is a high degree of variability between the types of duplications, they all fit the assumption that a disturbance of organizer phenomena underlies their formation. If one compares the abnormal mouse embryos with amphibian double monsters produced by constriction of eggs in different planes one finds amazing similarities between these two groups. While of course the *Ki*-homozygous embryos are not assumed to be the result of "constriction," the similarity with experimentally produced amphibian embryos suggests similarity of developmental mechanisms operating in the two types. These mechanisms concern the power of regulation, organization phenomena, and inductive interrelationships between different parts of the embryo, and the indicative evidence for their existence in mammalian embryos such as the mouse seems very strong on the basis of the analysis of abnormalities in *Ki/Ki* embryos. In amphibians the notochord-mesoderm forms the material basis for organizer effects, and similar conditions may exist in mammals; it is therefore perhaps permissible to conclude that in the mouse the disturbances of organizer and inductive phenomena described in *Ki*-homozygous embryos trace back to abnormalities of the notochord-mesoderm material.

Fused (*Fu*). As mentioned previously, Fused is conditionally lethal, i.e., embryos homozygous for *Fu* die on certain genetic backgrounds, but are viable on others. A systematic study of the development of Fused homozygotes dying before birth has not been completed, but preliminary studies show that severe abnormalities of head folds and neural folds are probably responsible for the prenatal death of these embryos (Gluecksohn-Waelsch, unpub.). It is not possible at this stage of the investigations to say if disturbances of the "Unterlagerung" of the neural plate, i.e., of notochord-mesoderm, or other causes are responsible for the abnormalities of neural fold development. But, at least, the results obtained do not exclude *Fu* from the group of mutations in linkage group IX in the mouse that affect the notochord-mesoderm system during the early growth and differentiation of the embryo.

t^1. One of the recessive mutations in this group, t^1, in homozygous condition affects the zygote before implantation in the uterus (Gluecksohn-Schoenheimer, 1938); the details of abnormalities of t^1t^1 embryos before implantation have not been examined.

t^9. The first of the recessive mutations in linkage group IX of the mouse, the lethal effect of which during development was studied in more detail, is t^9 (Gluecksohn-Schoenheimer, 1940). Embryos homozygous for t^9 die at the age of 5 days after fertilization, i.e., just about one day after implantation in the uterus. Such embryos never develop beyond the stage at which an inner cell mass, the ectoderm, becomes surrounded by a layer of entoderm. Normally, this inner cell mass becomes organized around the proamniotic cavity, it stretches and grows in length, and mesoderm formation sets in between the two layers of ectoderm and entoderm. These two important processes of embryonic differentiation, the organization of the ectoderm and the formation of mesoderm, fail to proceed in the abnormal embryos, which survive for about 40 hours without any signs of growth or differentiation before they disintegrate. The suppression of mesoderm formation and the absence of ectodermal or entodermal differentiation might be looked at as a complete failure of gastrulation, whatever gastrulation may be in a rodent embryo, with the embryos persisting in the blastula stage until they become necrotic and die.

t^4. One of the structures in the developing mouse embryo which has been considered to be homologous with the dorsal lip of the blastopore of amphibians is the so-called archenteron, a transitory structure in mouse embryos (cf. Sobotta, 1911). This structure, located near the anti-mesometral pole in the egg cylinder stage, is morphologically distinct as a slight depression or invagination. It has

histological staining properties different from the tissues surrounding it, and it separates the anterior embryonic region with three distinct layers from the posterior region with one continuous layer, a region whose developmental significance is not at all clear. The region of the transitory archenteron appears abnormal in embryos which are homozygous for another recessive mutation of the 9th linkage group, t^4, and which die around the age of 7 to 8 days after fertilization (Gluecksohn-Waelsch, unpub.). In general, complete failure of normal differentiation is found in these embryos in the egg cylinder stage, and t^4 thus takes its place with the mutations in linkage group IX described previously and found to interfere with the normal growth and differentiation of the embryo.

t^9. One further recessive mutation in this group is t^9, the study of which has not been completed but has already yielded very interesting results (Gluecksohn-Waelsch, unpub.). Embryos homozygous for t^9 have occasionally been found to show duplications of the type described above in *Ki/Ki* embryos. But in contrast to *Ki*, t^9/t^9 embryos do not regularly produce duplications; and those duplications which were found, were restricted to the nervous system. Several interesting conclusions, even at this preliminary stage of the investigations, may be drawn: (1) similar mechanisms to those disturbed in the case of *Ki/Ki* embryos must also be disturbed in t^9/t^9 embryos, though to a different extent; (2) the existence of duplications is again a confirmation of the existence of regulatory properties of the embryo as well as the presence of organizer and inductive phenomena, the material basis for which is provided by the notochord-mesoderm; (3) since t^9 shows similar effects to those of *Ki*, to which it is closely linked but not allelic, a region of the chromosome rather than a single "locus" seems to be involved in the control of the mechanisms directing the development of the notochord-mesoderm system.

t^{12} The time of death and the developmental disturbances of t^{12}/t^{12} embryos have not been investigated yet.

The detailed analysis of the effects of lethal factors in linkage group IX of the mouse has given significant information in several respects. Embryologically, the existence in a mammal of developmental mechanisms closely resembling those explored in other vertebrates by experimental methods has been strongly indicated (Gluecksohn-Schoenheimer, 1949b). Genetically, the factors controlling these developmental processes possess a number of unorthodox features and show most interesting interrelationships which are beyond the scope of this review (cf. Dunn and Gluecksohn-Waelsch, 1953). For the problem of the role of genes in the control of growth and differentiation these mutations in mice provide ample and interesting material (Gluecksohn-Waelsch, 1951).

CONCLUDING REMARKS

If we now try to consider what the study of lethal factors in development has so far contributed to the problems outlined in the introduction, it is necessary, first of all, to keep in mind the restrictions arbitrarily imposed on the material discussed in this review and mentioned in detail above. Furthermore, it should have become apparent by now that the interest of the author in problems of development has largely determined the selection of material and the point of view from which it was analyzed in this review. In the form of lethal factors affecting the development of *Drosophila*, the chick, and the mouse, a considerable amount of material exists which opens an approach to the problem of the role of genetic factors in growth and differentiation. A study of the actual number of lethal factors affecting *early* stages of development reveals this number to be small in all organisms considered in this review. Several reasons may account for this. First of all, the detection of lethal factors affecting very early development is more difficult than that of later acting factors; furthermore, a special interest in such early lethal factors on the part of the investigator is frequently a prerequisite for a systematic search for them. These are, however, not the only possible explanations for the scarcity of known lethal factors in early development of the higher organisms considered here. The regulatory power of such embryos, enabling them to call into action reserve forces for the repair of damages caused by external or internal injuries during development, may actually be the main cause for the relative scarcity of lethal factors in early development. This of course applies with equal justification to *Drosophila* as to vertebrate organisms. In the latter, in fact, so much is known about their regulatory capacity that time and place of regulation in response to effects of early lethal factors might at least be surmised.

Factors with potentially lethal effects might

thus well exist in larger numbers than are detectable and actually exert their effects; but as long as regulation is able to neutralize such effects the phenotype might remain either completely undisturbed or become abnormal but still viable.

The existence of regulatory power in early development is a well known fact in embryology. If an amphibian embryo, for example, is subjected to different kinds of injuries as the result of operations by the experimenter, its regulatory power enables it to repair the effects of the injuries and to develop into a perfectly normal individual showing no symptoms of abnormalities. This regulatory power is greatest in early developmental stages and diminishes as development proceeds. It is quite possible that the embryo is able to react to "injuries" caused by genetic factors in a similar manner, and that its regulatory power enables it to repair damages caused by genetic factors in very early stages of development so as to obscure their effects. It is, however, unable to do this in later stages—again in analogy with the diminishing regulatory power known from embryological experiments. Such regulatory power is certainly under genetic control, and it might be worthwhile to speculate a little about the type of genetic factors controlling it and about the mechanisms by which these factors might exert their regulatory effects. That genetic factors actually do exist which may change lethal factors into mutations permitting survival of the affected organism, was demonstrated in several instances above (viz., *crc*, short upper beak, Fused, *Sd*). Such factors were called modifiers, and their existence as well as their modification of primary effects of mutations have long been recognized by geneticists. The factors postulated to control regulatory power of an embryo in early stages would be similar to these modifiers but would be fixed in the species in such a manner as to show no effect of segregation. Their effective control would furthermore be assured by their large number so that a mutation in one or the other would remain ineffective. One of the possible mechanisms by which these genetic factors exert their control might well be based on a principle first revealed in the interpretation of phenomena of developmental mechanics, namely that of "double assurance," an extremely important general biological concept. First formulated by Braus, and then taken up by Spemann, who extended as well as clarified it, it was used for an interpretation of the developmental mechanics of eye development in certain amphibian species. In these species the ability of the eye cup to induce lens formation in epidermis exists simultaneously with the ability of the lens ectoderm to differentiate a lens in the absence of an inducing stimulus by the eye cup. Thus lens formation is "doubly assured"; if one of the mechanisms fails, the other may take over. This principle applies to a large number of developmental and general biological phenomena, and double or even multiple assurance may underlie the control of regulatory power of an embryo by genetic factors. If, for example, due to a mutation, a physiological deficiency develops and blocks a vital developmental process, the embryo would be unable to continue development and to survive. This "lethal" factor may, however, lose its lethal effect if now other genetic factors capable of performing the same process lacking in the mutants, but not actually doing it under normal conditions, take over and repair the deficiency; thus the "lethal" effect would become obscured.

A similar mechanism might well be operative in the effect of gene suppressors, the presence of which has been reported in *Drosophila* as well as in *Neurospora*. In such cases certain mutant effects may become obscured by the action of gene suppressors so that mutant factor and suppressor gene together may produce a phenotype identical with that of the wild type organism. The specificity of such gene suppressors varies and cases are known in both *Neurospora* and *Drosophila* where the same suppressor gene may obscure the effects of different mutants. The analysis of the mechanism of such suppressor effects in *Neurospora* should eventually be able to reveal the individual biochemical steps and the interaction of biochemical processes by which suppressor effects may operate. It seems reasonable to assume that modifier genes, suppressor genes, and the factors postulated here to operate in the control of regulatory power in early development belong in the same category of genetic factors. It is quite possible that in later stages, parallel with the diminution of regulatory power, the potencies of the genetic factors patrolling early development diminish also and that as a consequence the effect of the originally "lethal" mutation is not completely obscured any more, but expresses itself in some structural abnormality. In this connection it is interesting to note that there seems to exist in early embryonic stages of birds as well as of mammals, a high degree of resistance to the effects of different teratogenic agents, e.g., x-ray

radiation or chemicals. A relatively low incidence of abnormalities results from the exposure of such early stages to the same agents which when applied in later stages produce deleterious effects and high degrees of malformation. The same regulatory power protecting young embryos from lethal gene effects may be instrumental in the protection against these teratogenic agents. It would lead too far here to attempt a general discussion of the causes and the mechanism of loss of regulatory power as development proceeds. Suffice it to say that this problem is of course very closely linked up with that of differentiation in general.

The particular attempt made here of a synthesis of developmental concepts and principles with those of genetics for a possible explanation of certain phenomena in the genetic control of early development, is of course highly hypothetical and tries to formulate just one possible mechanism. Doubtless it would be possible to devise several other schemes of similar type. However, no evidence actually contradicting the present speculations seems to exist at the moment, and any consideration potentially helpful in bringing closer together the concepts of experimental embryology and of genetics seems worthwhile expounding.

As to the particular developmental mutations discussed here, it is by no means clear just where and how genetic factors operate in the mechanics and physiology of development of *Drosophila*. It was pointed out above that this is to a large extent the consequence of our relative ignorance of the causal morphology of *Drosophila* development.

In the chick, a large number of the lethal factors discussed express their effects in abnormalities of the skeleton. This may be a result of the selective force of the investigators' interest in this particular organ system. The developmental physiology of the skeletal system has no doubt profited particularly by the study of the effects of these factors and will certainly continue to do so in the analysis of the mechanisms operating in its development (cf. particularly the work of Landauer and Zwilling). Again, the number of early lethal factors is relatively small in the chick too, which may be explained at least partly by the role of regulatory power in development.

The study of lethal factors in mammals has led to the detection of developmental mechanisms resembling those known to exist in other vertebrates. From the point of view of the embryologist, this is perhaps the most satisfactory material of lethal factors, since it provides an approach to problems of development in organisms heretofore quite inaccessible to analysis. The existence of a number of hereditary factors in the mouse, all of them concerned with the control of the function of notochord-mesoderm material, is particularly remarkable in view of the fact that all these factors are located in one relatively short region of one chromosome. The failure to find similar factors in other chromosomes of the mouse may partly be connected with the paucity of such early lethal factors, but is to a considerable extent a consequence of the efficient detection mechanism for mutations in chromosome IX, i.e., the interaction of all *t*-mutations with *T*. In any case, it does not by any means indicate an exclusive role of Chromosome IX in the control of notochord-mesoderm material. The mechanism by which the factors in Chromosome IX exert their control on early development is still obscure at the moment. It is however necessary to take into consideration the genetic as well as the developmental peculiarities of these factors in any attempt to analyze such a mechanism. It is hoped that the continued study of lethal factors in development and of the mechanism by which they exert their effects might be able to contribute not only towards the solution of problems of the physiology of development and heredity but also to those of other branches of biology.

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THE ORIGIN AND EVOLUTION OF POLYMORPHISM IN ANTS

By EDWARD O. WILSON

Biological Laboratories, Harvard University

INTRODUCTION

In the biological literature of the past two decades the term *polymorphism* has been applied usually to one or the other of two almost completely separate phenomena. In genetics it is defined as the condition of two or more distinctive and discontinuous genetic types existing in a population (Ford, 1940). In the study of social insects it is defined as the existence within an individual colony of two or more phases or castes belonging to the same sex, without particular regard to their genetic or environmental origin. On the basis of usage by specialists on all groups of social insects a *caste* is properly defined as a differentiated morphological form with a specialized function, or at least the infrequent relict of such a form. It has been the practice of some entomologists to consider all abnormal, recurrent variants as castes and part and parcel of the species' colonial polymorphism. Actually, these cannot be considered apart from similar variants in non-social insects, and their inclusion obviously breaks down the original meaning of polymorphism by neglecting its relation to social organization.

The following paper is an attempt to summarize our existing knowledge of polymorphism in ants and to reinterpret it in terms of the hitherto unappreciated but tremendously important underlying features of adult allometry and intracolonial size frequency distribution. [In its broad sense allometry is defined as the regular disproportionate ontogenetic growth or adult variation of two organs or linear dimensions related as $y = bx^k$, where k is the *equilibrium constant* and the slope of the log-log plot of the curve. A fuller explanation is offered in a subsequent section.] The study of the latter phenomena has of late been shedding unexpected new light upon the nature and phylogenetic development of polymorphism. It is felt that further work in this direction will continue to yield information significant not only for the special fields of ant taxonomy and ant sociology but also for the general province of growth physiology.

CASTE DETERMINATION

In ants it is typically the female which is polymorphic, with an average colony consisting of two basic female castes, the queen (reproductive female) and the worker (sterile female). The queen and worker may in turn be connected by intermediate stages which are often stable enough to be recognized as distinct castes, while the workers may become subdivided into several additional castes. It is probable that sex is determined, as in most other Hymenoptera, by the genetic mechanism of haplo-diploidy. Although no direct cytological evidence has been adduced in support of this, it is indicated by a great body of indirect evidence which includes the existence of a number of undisputed gynandromorphs and the tendency for all unfertilized eggs to produce males. Probable cases of thelytoky have been reported in several species of ants (Gösswald, 1933; Haskins and Enzmann, 1945; Ledoux, 1950) and need additional investigation, but they are still explainable on the basis of genome duplication or the failure of meiosis, and may not form exceptions to haplo-diploidy.

The preponderance of evidence at the present time indicates that queens and workers are genetically similar and that the caste of an individual female is determined by the food given it as a larva. A miscellany of experiments over the past sixty years has always seemed to show that starved larvae tend to produce ordinary workers (minors), while well-fed larvae produce majors (soldiers) or queens (Light, 1942–1943). However, nearly all early work of this nature included no controls and was based on very small samples, so that most of the critical evidence is carried in the independent studies of three recent workers, R. E. Gregg, M. V. Brian, and A. Ledoux. Gregg (1942) followed the lead set in experimental work on termite castes by

studying the effect of the complete removal of one caste on the major-minor ratio. He was able to show that colonies containing only majors produced a significantly smaller proportion of new majors than those containing only minors. From this he postulated the existence of a hormone secreted by the majors which tends to inhibit the production of additional members of their own caste. Certain discrepancies hinder the acceptance of this specific explanation, as Light (*op. cit.*) has pointed out. The efficiency of the majors as nurses was not determined, the adult mortality of most of the colonies was such to suggest abnormal conditions in the artificial nests, and the highly critical matter of larval mortality was not discussed at all. But while Gregg's data are not of a nature to allow interpretation of the exact trophic factors involved, they do strongly suggest that the destiny of an individual *Pheidole* as a minor or a major is decided during the larval period.

M. V. Brian's recent preliminary report on caste determination in *Myrmica rubra* L. (1951) is the most illuminating to appear on the subject to date. *Myrmica rubra* larvae hibernate in the third stadium, and in the spring those which are able to reach a critical size of about 6.5 mg. by a certain time (unspecified by Brian) are able to attain queenness, while those below this size become workers. The queen-potential larvae must then reach another critical size of about 7.0 mg. before pupation in order to become normal queens. Brian states that "it is necessary to suppose that an extra impetus to growth is given to queen determined larvae and withheld or actually withdrawn from those which fail to secure induction." This account of caste determination sounds especially promising, should Brian's as yet unpublished data warrant his conclusions, since it seems to be fully consonant with many of the details of trophic behavior in ants. For instance, the extra impetus assumed by Brian may originate from the proportionately larger fat body found in queen and soldier larvae of many ants. Such larvae have more "bargaining power" in trophallactic exchange with the adult workers and might thus accelerate their own growth. Weber (in Wheeler, 1937) observed in an *Atta cephalotes* colony that two of the larger larvae were actually segregated from the smaller larvae and fed more frequently by the adults, which were evidently attracted by their abundant fatty secretion and vigorous supplicatory "pouting" movements

In his studies on *Oecophylla longinoda* (Latreille), Ledoux (1950) has added significant information to the concept of critical developmental times and subsequent regulation of growth in larval development. *Oecophylla longinoda* possesses dimorphic workers and therefore three distinct female castes, the queen, major worker, and minor worker. There is good evidence to show that the critical time of queen-worker divergence is in very early larval life, while that of the major-minor divergence is at some time during the second larval stadium. Past the second ecdysis, collections of larvae of any given age can be separated into three size groups which correspond to the three female castes.

It would appear from the foregoing evidence that in the case of the determination of two segregated castes, growth trends are fixed at a certain age and proceed without interruption to form the adult ant. It should be emphasized, however, that the larval growth is merely a preliminary to the stage of growth which is actually destined to give rise to the final adult shape. As will be demonstrated in more detail later, the main features of adult caste formation are dependent solely on differential growth in the imaginal discs and probably only at the onset of pupal development, after the larval tissues have ceased growing. The important determination which occurs during larval development appears to be in the specific growth-rate potentials of the imaginal discs which reside in the larva. The growth of the larval tissues themselves, apart from that of the imaginal discs, is approximately regulated to allow the final expression of the disc potentials.

Considerable indirect evidence also strengthens the impression that trophogenesis of castes is universal in the Formicidae. In several species of ants, including members of the Ponerinae (*Pachycondyla*, *Neoponera*), Odontomachinae (*Odontomachus*), Myrmicinae (*Pheidole*), and Formicinae (*Camponotus*), infection of the worker by parasitic mermithid nematodes produces a peculiar feminization which is closely akin to parasitic castration. A thorough study of the external morphology of these modified individuals in *Pheidole pallidula* (Nylander) has been made by Vandel (1930), who has observed that in this species only the major is affected (producing "mermithostratiotes"). An examination of his graph and figures shows that the modified majors are in respect to the structure of their heads little more than major-minor or major-

queen intercastes. Their thoraces are typically major-like in form. The mermithids are presumed to enter their hosts during late larval or early pupal life; in the case of the mermithostratiotes it is probably the former, since the adult form of the ants is assumed immediately upon the initiation of pupal development.

It is possible to relate Vandel's mermithization effect to the modifications in form described by Wheeler (1937) in his *Acromyrmex octospinosus* Reich "caste mosaics." The latter aberrations are of two principal types, "gynandromorphs" and "gynergates." The former possess normal male bodies with heads seemingly divided into male and female components, while the latter have normal major bodies with heads seemingly divided into major and queen components. Both are essentially the same type of phenomenon, but it is the gynergates upon which most of the theoretical consideration has been concentrated. Wheeler believed that his gynergates represent genetic mosaics no different in type from true gynandromorphs, and that female castes must therefore be genetically determined. In the year following, Whiting (1938), offered an alternative explanation which is the one generally accepted today. He pointed out that Wheeler's mosaics are quite different from true gynandromorphs as recognized in other Hymenoptera. The ant mosaic patterns are all limited to the head and are more or less regularly disposed, while in true gynandromorphs the male and female components vary in extent and are distributed at random over the entire body. Whiting proposed that Wheeler's mosaics are likely to be intersexes of the type described in the moth *Lymantria dispar*, and that the head alone was affected because this was the only part not past the final critical threshold when the transition from femaleness to maleness began. We might assume from Whiting's reasoning that the intercaste condition of the head could result secondarily from the shift toward maleness; in other words, the shift pulls the head across the threshold toward queenness.

Thus in both Vandel's mermithostratiotes and Wheeler's mosaics there appears to have been a late and forced trespassing of the queenness threshold by the head under exceptional physiological conditions. That the head should prove the most labile of any of the major parts of the body of a larva which has passed the critical time of the queen-worker divergence is fully in accord with present knowledge concerning the allometric basis of polymorphism. The data to be presented shortly show that cephalic allometry is nearly always involved in some way with the differentiation of female castes, and that in the case of the initial segregation of queen and worker it continues to be expressed long after other types of allometry are no longer evident.

One additional recent hypothesis concerning the trophogenic basis of caste determination in ants is of sufficient interest to mention in passing. Flanders (1945, 1952) has suggested that the amount of yolk in the egg could determine caste and that the caste might therefore be determined by the extent of ovisorption taking place in the oviducts of the queen. Differential ovisorption has been demonstrated to be the basis of some discontinuous variation in parasitic (terebrant) Hymenoptera, and there is little doubt that the same situation could hold in the aculeates also. According to Flanders, the hypothesis gains strength when it is recalled that ovisorption can be an inverse function of the rate of oviposition, and that the larger workers and sexual forms of ants tend to appear at times when the rate of oviposition is greatest in the colony history. Unfortunately, Flanders has passed by a great many published accounts of experiments which seem to indicate that the course of development in a larva from any given egg can be affected by nutritional changes regardless of the original condition of the egg. Also, he has overlooked previous attempts to distinguish ovarian caste differences which have yielded negative or contrary results (Bhattacharya, 1943; Ledoux, 1950). But the possibility still remains that the amount of yolk in an egg might affect the *chances* of a larva reaching the threshold values before the critical times. This may prove to be a valuable path of research to follow.

Polymorphism, as now understood, can be interpreted as a function of two variable characters of the adult females of any ant species: allometric growth series and intracolonial size variation. The most useful and applicable definition of polymorphism which also approximates the subjective concepts of previous workers is believed to be as follows: *allometry occurring over a sufficient range of size variation within a normal mature colony to produce individuals of detectably different form at the extremes of the size range.* In all ants, with the exception of a few degenerate parasitic forms and some ponerines, there are well differentiated queen and worker castes, so that in this sense polymor-

phism is an elementary condition. As the worker caste becomes divided into secondary castes through allometry, it is itself called polymorphic, and it must be remembered that in most taxonomic work application of the term *polymorphic* is usually restricted to the worker.

The principal allometric growth-center (point of greatest allometry; see Huxley, 1932) can occur in any part of the body. In the queen-worker differentiation it is in the mesothorax, with lesser ones following in the gaster and head. In major-minor differentiation, it is typically in the head, while lesser ones may occur in the gaster and various parts of the alitrunk. The allometric change may affect any or all features of the allometric structure, including total size, shape, spination, ommatidium number, details of sculpturing, and deposition of pigments, with the result that the extreme size forms are often strikingly different from one another. Dimorphism, or total bimodality with the elimination of intermediates, is a secondary condition and has produced in the evolution of the Formicidae first the segregation of the queen from the worker caste, and second, in many taxonomic groups independently, the segregation of the minor from the major worker caste. The condition of "partial dimorphism" refers only to the frequency and may be defined as clear-cut bimodality with overlap in the ranges of the two constituent curves.

It must be emphasized at this point that all degrees of intranidal allometry within the worker caste can be demonstrated, grading almost insensibly into absolute monomorphism. Each of the most prolific workers in systematic myrmecology, including Emery, Forel, and Wheeler, had his own idea of approximately where monomorphism stopped and polymorphism started, with the result that all rarely agreed on the status of feebly polymorphic species, and each tended to judge the matter according to how carefully he had examined the material before him. Within the gradient of increasingly allometric species it is impossible to draw a precise line as the lower limit of polymorphism so as both to adhere to previous usage and remain consistent throughout. It is necessary to set as an absolute standard the concept of detectable intranidal allometry. The objection may be raised that such a criterion will include many borderline cases that can be checked only upon careful measurements. Yet in many forms which are universally considered to be polymorphic, such as *Lasius fuliginosus* (Latreille) and a great many of the species of *Dorylus*, the allometry can be detected only by microscopic examination.

Some recent workers, including Falconer Smith (1942), Cole and Jones (1948), and Haskins (1950), have heavily emphasized the role of multimodality and intimated that worker polymorphism should somehow be defined in terms of frequency. Very possibly they were influenced by Wheeler's suggestion (1937), based on his predilection for blastogenesis and an erroneous interpretation of frequency curves of the sort published by Buckingham (1911), that the formation of castes is associated with a tendency toward frequency grouping. My own study has shown that bimodality, emerging from a skewed unimodal condition, closely follows upon the development of intranidal allometry and is correlated with later changes in the allometric regression line. However, trends toward the development of more than two modes are rare (see Fig. 5), and many polymorphic species are apparently unimodal.

TRENDS IN ALLOMETRY AND FREQUENCY

The queen and worker castes are usually separated from one another by a considerable gap with no intermediates, so that only in rare cases can their precise relationships be determined. The worker caste, on the other hand, shows within itself all transitions from monomorphism through elaborate allometry to total subdivision into major and minor castes. There is a good amount of evidence to indicate that this gradual development of dimorphism as seen from species to species represents the trend prevalent in the evolution of any one dimorphic species. The same steps have been encountered in nearly every group where a transition is present, and there can be no question that in most of these groups extreme polymorphism or dimorphism has been independently evolved. The principal stages as recognized at the present time are discussed in some detail below.

1. Monomorphism

The normal mature colony is either isometric or with limited size variability, or both, and its frequency distribution is unimodal. Secondary monomorphism often succeeds phylogenetically some development of polymorphism and is produced by a dropping out of a large segment of the size variation. This typically results in a caste which is even

more uniform than the workers of a related, primarily monomorphic species. Well known examples of both types of monomorphism include the species of *Ectatomma*, *Myrmica*, and *Carebara*. (See Fig. 2A.)

2. *Monophasic allometry*

The allometric regression line has a single slope, the condition usually called "simple" allometry by students of growth. A common condition encountered in many genera, and exemplified by such forms as *Eciton nigrescens* (Cresson), *Formica obscuripes* Forel, and *Lasius fuliginosus* (Latreille), is that of feeble monophasic allometry expressed over a short range of size variation, which in turn shows a unimodal frequency curve. There is limited evidence to indicate that the extremes of this variation may serve as functional castes. Alpatov (1924), for instance, has observed some division of labor in the European *Formica rufa* Linné. An apparently later development in monophasic allometry involves an increased dispersion of the frequency curve for size, a condition combined with a marked tendency toward bimodality. This is the typical condition in many genera which are often cited as showing elementary polymorphism or partial dimorphism, including *Megaponera*, *Orectognathus*, *Azteca*, and *Camponotus* (Figs. 1, 2). Within *Camponotus*, polymorphism of this type has been demonstrated to be correlated with intracolonial division of labor (Buckingham, 1911; Lee, 1938).

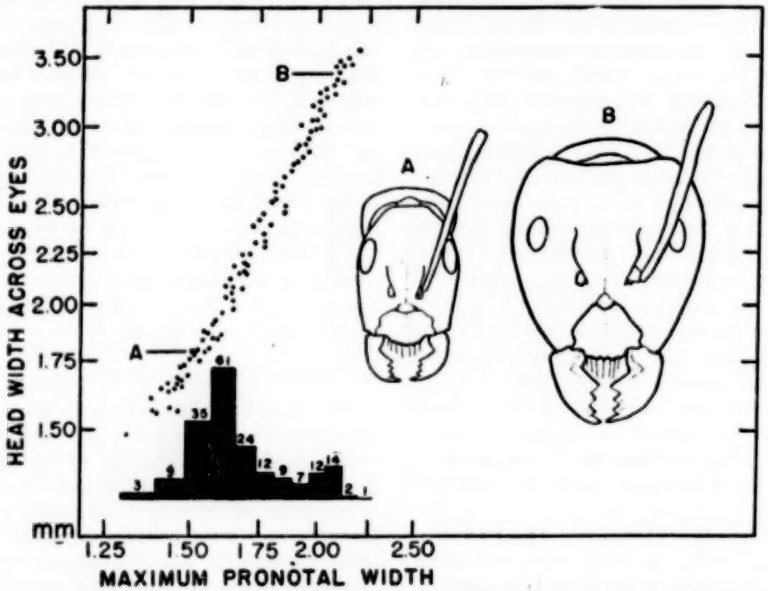

FIG. 1. INTRANIDAL MONOPHASIC ALLOMETRY AND INDISTINCTLY BIMODAL FREQUENCY IN CAMPONOTUS CASTANEUS (LATREILLE) (SUBFAMILY FORMICINAE)

Frontal views of heads and pronota of minor (A) and major (B) workers are shown, along with the placement of these individuals on the allometric regression line. Equilibrium constant (k) = 1.9. Calculated maximum error = ± 0.04 mm. Based on a single nest series, Knoxville, Tenn., W. J. Cloyd leg. In this and the following graphs, individual measurements pertaining to allometry are given, and both the allometric dimensions and the abscissa of the frequency curve are plotted *logarithmically*. All measurements have been taken with an ocular micrometer at magnifications of 24× to 90×. The calculated maximum error is defined as plus or minus the unit or unit-fraction to which the measurements are made; repeated checks have shown that the actual maximum error is in practice usually smaller than the calculated one.

3. *Diphasic allometry*

The log-log allometric regression line "breaks" and consists of two segments of different slopes meeting at a critical point. In the several instances where this condition has been demonstrated, the frequency curve is bimodal, and the trough between the overlapping constituent curves tends to

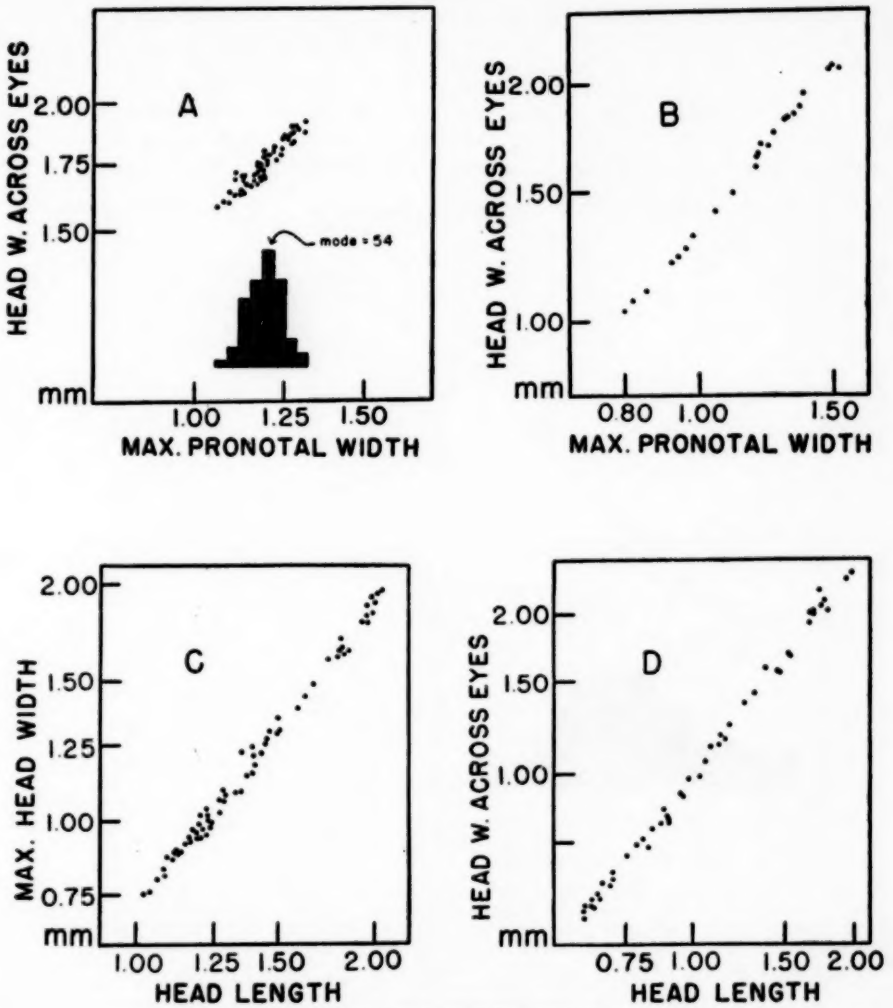

FIG. 2. MONOMORPHISM AND MONOPHASIC ALLOMETRY IN ANTS

A, monomorphism in *Formica exsectoides* Forel, characterized by isometry, limited size variation, and unimodal frequency. B–D, monophasic allometry over considerable size variation in B, *Megaponera foetans* (Fabricius) (subfamily Ponerinae), $k = 1.2$; in C, *Orectognathus versicolor* Donisthorpe (subfamily Myrmicinae), $k = 1.2$; in D, *Solenopsis geminata* (Fabricius) (subfamily Myrimicinae), $k = 1.2$. All three of these species show size frequency which is bimodal to some degree. Allometry in all four species shown as a log-log plot. Maximum calculated error in A, ± 0.010 mm; in B, ± 0.014 mm; in C, ± 0.020 mm; in D, ± 0.017 mm. A, single colony from Sudbury, Mass., E. O. Wilson leg.; B, material from several African localities, in Wheeler Coll.; C, material from five colonies several localities, Australia, W. L. Brown leg., data partly from Brown (unpub.); D, single colony from Mobile, Ala., E. O. Wilson leg.

fall just above the critical point of the break. Diphasic allometry appears to be a mechanism allowing the stabilization of a small caste, while at the same time providing for the production of a markedly different major caste over a slight size increase. The lower segment of the allometric regression line is usually nearly isometric, so that individuals falling within a large portion of the

size range tend to be proportionately uniform in structure, but the upper segment is strongly allometric, with the result that a small increase in size yields a distinct new morphological type. In the fungus-growing ant *Atta texana* (Buckley) the cephalic allometry is actually reversed from negative to positive at the critical point (Fig. 3). The upper segment leads to the large-headed soldiers which in most species of *Atta* function primarily in defense of the nest (C. R. Gonçalves, pers. commun.). If this higher equilibrium constant were maintained past the critical point without a break, forms somewhat below the critical point would become microcephalic and probably inviable. A shift to a negative constant allows the production of very small normal-headed workers, which are very important or even essential for tending the fungus gardens on which the ants live.

4. *Triphasic allometry*

The log-log allometric regression line "breaks" at two critical points and consists of three segments; the terminal segments have varying equilibrium constants, but the middle segment is very highly allometric. The regression line greatly resembles a logistic curve and could be interpreted in terms of curvilinearity, but the concept of straight segments is retained here for consistency. The effect of triphasic allometry is the stabilization of both the major and minor castes. This condition may succeed phylogenetically diphasic allometry, which first stabilizes the minor caste, or it may emerge from monophasic allometry, as seems to be the case in the partially dimorphic *Camponotus* (see below). Triphasic allometry has been analyzed in two forms, *Oecophylla smaragdina*

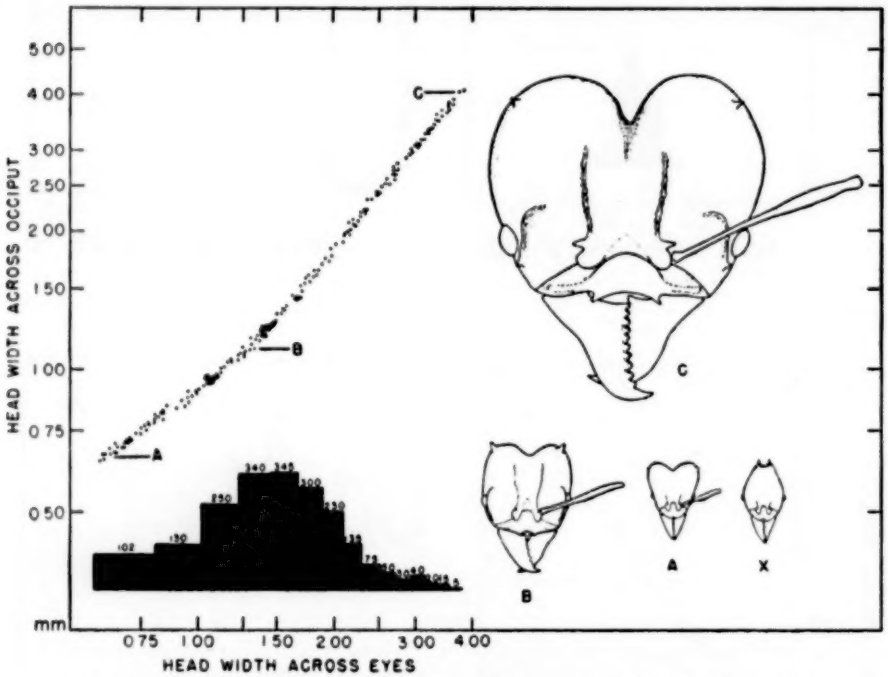

FIG. 3. DIPHASIC ALLOMETRY IN ATTA TEXANA (BUCKLEY) (SUBFAMILY MYRMICINAE)
Log-log plot. Note the great range of size variation and probably bimodal frequency curve. A, head of minima worker; B, head of small media at the point of the break in the allometric regression line, where the occiput width is relatively narrowest; C, head of major worker; X, head of hypothetical worker which would presumably result if the upper segment of the allometric regression line were to be extended to the minima size class. *k* of lower segment, 0.8; of upper segment, 1.3. Calculated maximum error, ± 0.013 mm. Based on a single colony collected by U.S.D.A. workers at Austin, Texas. The frequency curve was modified from measurements made on total length by W. J. Cloyd (1950, unpub. Master's thesis, Univ. of Tennessee).

(Fabricius) and *Pheidole rhea* Wheeler (Figs. 4, 5). Both approach complete dimorphism, with very few intermediates in a nest series connecting the constituent curves. In both cases the trough between the curves corresponds to the middle segment of the allometric regression line. Significantly, the middle segment comprises an apparently unstable size class, for its regression coefficient possesses an unusually high standard error of estimate. *Pheidole rhea* shows the very interesting and rare condition of trimodality. This species is one of several polymorphic members in a genus which is predominantly completely dimorphic, and its unusual polymorphism may actually have been derived from a dimorphic condition.

Triphasic allometry probably occurs also in *Cataglyphis bombycina* (Roger) and species of *Paracryptocerus*, but insufficient material has been available to allow this to be determined with certainty. An interesting case which may represent triphasic allometry in its incipiency is seen in *Camponotus abdominalis floridanus* (Buckley) (Fig. 6).

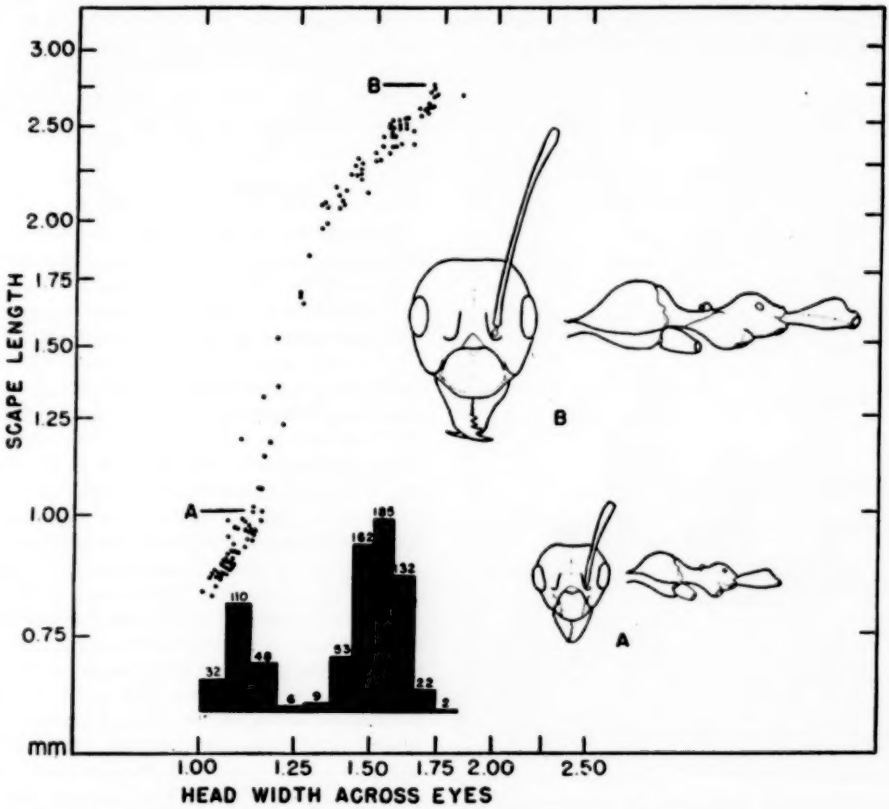

FIG. 4. TRIPHASIC ALLOMETRY IN OECOPHYLLA SMARAGDINA (FABRICIUS) (SUBFAMILY FORMICINAE)
Log-log plot. A, head and alitrunk-petiole of minor worker; B, same of major worker. Calculated maximum error ± 0.010 mm. Frequency modified from measurements by Cole and Jones (1948) on alitrunk length. Both curves based on two colonies from upper Assam; A. C. Cole leg. Figures based on Philippine material in the Wheeler Collection.

5. *Complete dimorphism*

Two separate size classes exist, separated by a gap in which no intermediates occur. Each class possesses an equilibrium constant approaching unity, but the allometric regression curves are not aligned, a fact suggesting that this condition may

arise directly from triphasic allometry. Examples include most queen-worker segregations and a great many major-minor divisions in such genera as *Pheidole*, *Ischnomyrmex*, *Zatapinoma*, *Pseudolasius*, and *Camponotus*. Once complete dimorphism is established, the two resultant castes are capable of diverging further in some parts of the body, with no evident intergradient allometry. Profound changes may occur in the appearance or

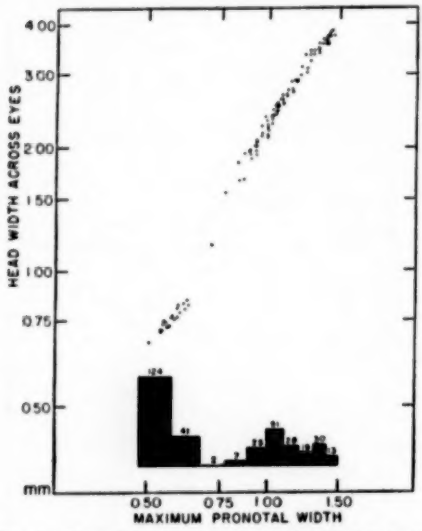

FIG. 5. TRIPHASIC ALLOMETRY IN PHEIDOLE RHEA WHEELER (SUBFAMILY MYRMICINAE)

Log-log plot. Note the exceptional trimodal frequency. The trough between the modes of the two larger size groups may correspond to an additional, fourth break in the allometric regression line; this is weakly evident in the above plot. Calculated maximum error, ± 0.010 mm. Based on a single colony, Nogales, Arizona, R. E. Gregg leg.

size of one or both of the castes, so that their original relationship might never be suspected if earlier phylogenetic stages were not exhibited by other species. In some groups the head of the largest workers comes to surpass in size that of the queens (some *Pheidole*, *Messor*, *Camponotus*, etc.), while in others the queen regresses in total size to become smaller than the average worker (*Formica microgyna* group). In at least two genera (*Melissotarsus*, *Acanthomyrmex*) there are species in which the non-allometric parts of the major may be equal in size to those of the minor, or smaller. It seems to be a rule among ants that once the secondary divergence of completely segregated castes becomes profound, the physiological thresholds separating them are no longer capable of being broken down to produce intercastes. At least one forceful exception exists, however; ergatogynes appear to be relatively common in the dimorphic genus *Oligomyrmex* (see, e.g., Kusnezov, 1951). Another feature of complete dimorphism is that it may be expressed in one character but not in another. In the queen-worker divergence, for instance, the alitrunk becomes dimorphic at a phylogenetically early stage, but recurrent allometric trends in the head may continue to link the two casts by a monophasic regression line.

DEFINITIONS OF CASTES

The nomenclature which has been built up in the past has always been excessively complicated and vacillating, which might be taken to be an implicit gesture of despair. The last attempt to treat comprehensively all of the recognized castes and to apply names to them was that of Wheeler in 1937. At this time Wheeler felt doubly justified in distinguishing each non-parasitogenic variant known to him, because he believed that each has arisen independently as a mutation. A reevaluation of Wheeler's classification reveals that many of the names proposed by him are superfluous, some are for practical purposes synonymous, and some are but stages in an allometric progression. Part of the reason for Wheeler's excess terminology was that he saw no difference between normal functional castes and true anomalies; to him all except the queen and typical male were basically anomalous forms, and he alternately referred to them as castes, phases, and anomalies. The necessity of distinguishing between normal castes and pathological forms has been previously emphasized. In the classification presented below, obviously pathological forms have been eliminated, and an attempt has been made to utilize names which will be useful in future descriptive analyses and most consistent with the allometric character of the female castes.

1. *Male.* Ordinarily possessing a generalized hymenopterous thorax and fully developed, nondeciduous wings. Apterous in some parasitic species such as the aberrant *Crematogaster* (*Apterocrema*) *atillanica* Wheeler.

2. *Ergatomorphic male.* With normal male genitalia and a worker-like body. So close is the resemblance in some species of at least the anterior part of the body to that of the worker that it may

be eventually shown, as Wheeler has suggested, that these forms are actually persistent ergatandromorphs. Occurs in species of *Ponera*, *Cardiocondyla*, and *Formicoxenus*.

3. *Queen*. As recognized by Wheeler and others, the fully developed reproductive female, possessing a generalized hymenopterous thorax and fully developed, deciduous wings. This caste includes the teratogyne and microgyne of Wheeler.

4. *Worker*. The abortive, ordinarily sterile female, possessing reduced ovarioles and a greatly simplified thorax, the nota of which are usually represented by no more than a single sclerite each (Tulloch, 1935). Includes the macrergate, gynaecoid, and cryptogyne of Wheeler. Subcastes in a polymorphic worker series are designated approximately according to the relative size of the allometric organ as the *major* (soldier), *media*, and *minor*. In some cases of triphasic allometry these correspond to the three segments of the allometric regression line, and in complete dimorphism the media drops out.

5. *Ergatogyne*. Individuals falling along the allometric progression connecting the queen and worker castes, ranging from subapterous forms with queen-like alitrunks to slightly gynecoid workers. The normal major workers of genera such as *Pheidologeton* have ergatogynic thoraces, so that it is difficult to draw a precise line between these two castes. Perhaps it will prove best in the future to consider only those individuals in the upper segment of the diphasic allometric regression line as ergatogynes. Stable ergatogynes are the normal reproductives of some species of *Leptogenys* and *Monomorium*, and they are the only female caste known in the parasitic genus *Epixenus*. This caste probably includes the aberrant workers of the genus *Diacamma*, designated by Wheeler as "diacammatogynes." Pseudogynes, once assumed to be pathological ergatogynes, have recently been shown to be the result of an unrelated type of abnormal worker growth probably initiated by specific hormonal secretions (Novak, 1948).

6. *Physogastric ergatogyne*. Many ergatogynes show a divergent trend away from the normal queen-worker series in that the development of the gaster and postpetiole outpaces that of the thorax and head. The forms which are thus produced possess a gaster which approaches in size that of the typical female, while the thorax and head are only slightly ergatogynic. These intercastes may serve as complementals or may replace the normal queen. Includes the ergatoid and physergate of Wheeler.

7. *Dichthadiiform ergatogyne*. This caste appears to be the extreme stage of the physogastric trend, of which the reproductive female of *Acanthostichus quadratus* Emery might be said to be an intermediate stage. The total size is greatly increased, the gaster is huge, and the postpetiole is expanded

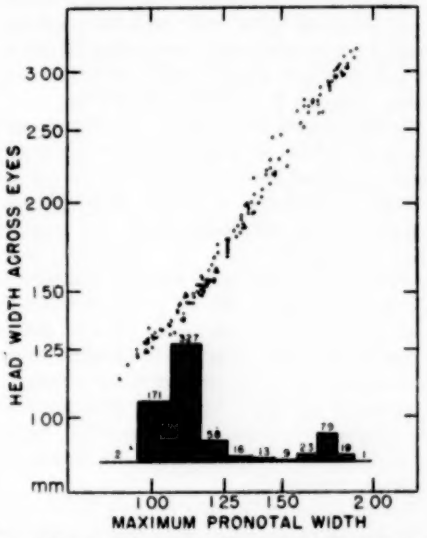

FIG. 6. POSSIBLE INCIPIENT TRIPHASIC ALLOMETRY IN CAMPONOTUS ABDOMINALIS FLORIDANUS BUCKLEY (SUBFAMILY FORMICINAE)

Log-log plot. Calculated maximum error, ± 0.013 mm. Frequency based on a single colony, Welaka Co., Fla., A. Van Pelt leg. Allometry based on this colony and on two others from Orange Beach, Baldwin Co., and Chattahoochee St. Pk., Houston Co., Ala., E. O. Wilson leg.

to the extent that it appears to be the first gastric segment. One gets the impression of a greatly increased positive allometry in the posterior part of the body, with a growth center located in the gaster and a growth gradient proceeding anteriorly to enlarge also the petiole and propodeum. In addition, the head is broadened and rounded and the mandibles are often falcate. Occurs typically in most groups with a legionary mode of life, and includes all known Dorylinae and Leptanillinae and the ponerine genera *Simopelta* and *Onychomyrmex*.

THE THEORETICAL BASIS OF ALLOMETRY

Huxley (1927, 1932) was the first to show that polymorphism in ants can be related to allometric

growth in other animals. At the same time he made the excellent suggestion, surprisingly neglected by subsequent writers on caste determination, that the presence of a gradient allometric series connecting the major and minor castes of the same species can be explained most simply on the basis of variable nutrition. Since Huxley's inauguration of the allometry concept in the 1920's, a great deal of significant experimental and descriptive research has been added to it, with the result that much more is now known concerning its physiological basis and general applicability (see, e.g., Brody, 1945; Le Gros Clark et al., 1945).

In the present study all of the growth-ratio curves have been analyzed according to the allometric equation, but not all are known to conform exactly to allometry. The more strikingly polymorphic forms with considerable size variation, such as *Solenopsis*, *Atta*, and *Camponotus*, have growth curves which have been demonstrated in the present study to fit the power equation far more precisely than any other form of general equation. In many other cases, especially where the curve proves to be irregular or polyphasic, the logarithmic plotting is by far the most amenable to descriptive analysis. For pragmatic reasons alone, then, the power equation has been used consistently throughout.

Simple allometry is expressed as $y = bx^k$ where y is the size of the allometric organ, x is the size of the rest of the body or of an organ against which y is compared, b is the "initial growth-index," and k is the "equilibrium constant." This can be converted into logarithmic form as $\log y = \log b + k \log x$, so that no matter what the value of k, the regression line should be rectilinear on a double logarithmic plot. This equation can be directly derived from the differential multiplicative growth of two organs:

$$y = ce^{k_1 t_1} \quad \text{and} \quad x = de^{k_2 t_2}$$

where t is time. Taking the natural logarithms and differentiating, the two specific growth rates are obtained:

$$k_1 = \frac{dy}{ydt} \quad \text{and} \quad k_2 = \frac{dx}{xdt}$$

The equilibrium constant k is the ratio of the specific growth rates k_1/k_2 when $t_1 = t_2$. The times of development can be considered equal in the derivation of this equation if one of two conditions is assumed: either that the developments of the two organs started at the same time, or that the relationship is considered only over a segment of the developmental time. In considering allometric series in holometabolous insects, the full course of development is never discerned and only the latter condition of time can be assumed, so that the initial growth index b has no significance. For practical purposes, in the present study only the equilibrium constant k has been considered, and this has been obtained geometrically by measuring the slope of the log-log regression line. The value thus obtained has been found by repetitive tests to be precise to the first decimal place, which is sufficient for descriptive purposes. Future work, involving exact comparisons, may demand that the equilibrium constant be carried to a further decimal place. It should be remembered, however, that a constant based on linear measurements carries no physiological implications by itself, since it is only an approximate function of the absolute allometric value, which appertains to mass or volume.

It can be seen that allometry might have a very sound theoretical basis if growth could be shown to be always a uniformly multiplicative process. Unfortunately, this is rarely the case. The physiological mechanisms of differential growth are only partly understood, and in certain features, such as competition between parts and specific organ competence in relation to age, the data appear to be partly conflicting (Reeve and Huxley, 1945). There is also an outstanding paradox involved, in that certain complex histogenetic phenomena, such as the development of membrane bones, are totally unlike simple multiplicative growth and yet still conform to the power equation. However, despite these exceptions and theoretical difficulties which have come to light, allometry remains the most general and meaningful expression of relative growth.

A number of cases of deviations from typical allometry have been recorded from various groups of animals. Two types have been discovered in ants: polyphasic regression lines, which have already been shown to represent a fundamental trend in the development of castes; and lines which remain curvilinear on a log-log plot. Neither seem amenable to a physiological explanation at the present time. Polyphasic regression lines have been reported before in other arthropods, where their critical points are usually associated with successive molts (Teissier, 1937; Yasumatsu, 1946). Curvilinear regression on log-log plots has been ob-

tained in scape length against head width in *Atta texana* (Fig. 7) and in mandible length against head length in *Orectognathus versicolor* Donisthorpe. It may be of significance that similar curvilinear trends have been found in the rostrum and mandible lengths of several genera of fish (Reeve and Huxley, 1945). The case of *Atta*, where two closely approximated structures show different types of allometry, brings to emphasis one of the weaker aspects of any statistical analysis of the sort conducted here on ants. Where complex allometry is involved, we speak of the allometric trend of a given species, but we are actually referring to the most prominent allometric character which has been chosen for study. Only by an exhaustive treatment of all parts of the body and the localization of growth centers and growth gradients can the real patterns of growth be described.

Still one more complication remains in the physiological interpretation of ant polymorphism. As in similar studies on other holometabolous insects, measurements are always taken from permanently formed imagines and therefore do not involve ontogenetic growth directly. Huxley (1932, 1945) is of the opinion that allometry in this case is derived through differential growth of adult tissues within the pupa, but a careful examination of the details of metamorphosis shows that the process is actually far more limited than this. The gross adult form, complete with the major allometric relationships of the external organs, is revealed suddenly in the early pupa at the last larval ecdysis, while the internal adult tissues which fill this mold do not begin development until a later period. It is evident that the allometry is first expressed in the configuration of the pupal hypodermis, so that the differential growth involves the multiplication and deployment of the epidermal cells. How such a process may occur has been determined recently by C. M. Williams (pers. commun.). In the moth *Platysamia cecropia* (Linné) the imaginal discs remain isometric in relation to the rest of the body and to one another through the larval period. During the prepupal stage, certain imaginal discs begin a precipitous growth while others, such as those destined to form the gonads and external genitalia, remain dormant and begin to grow rapidly only after the onset of adult development within the pupa. Also during the prepupal stage the pupal hypodermis is laid down in the course of a spurt of growth and forms molds in which the adult wings, antennae, and legs develop. Since the proliferation of the discs which form the various areas of the hypodermis proceeds at various rates, it is conceivable that at least the major features of allometry expressed between adult insects originates through simple multiplicative growth at this level. Lesser details of allometry in segmentation, spination, pigmentation, etc., may not appear until the onset of adult development. This particular aspect of allometric growth should prove a rich field for future research.

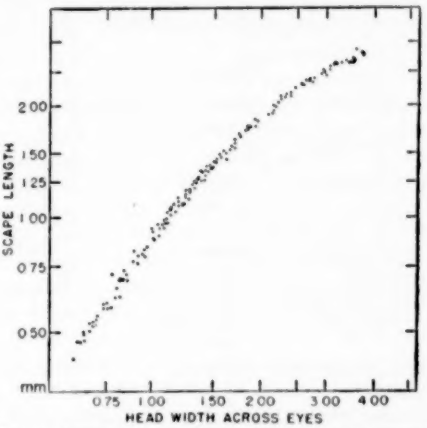

FIG. 7. ATYPICAL ALLOMORPHOSIS IN THE MANDIBLE LENGTH OF ATTA TEXANA, SHOWING EVEN CURVILINEARITY IN A LOG-LOG PLOT
Same colony as in Fig. 3. Calculated maximum error ± 0.013 mm.

AN INDEX OF POLYMORPHISM

It would be very desirable, if possible, to obtain a quantitative measure of polymorphism which could be used in comparing species or higher categories, because subjective evaluation has proven patently inadequate. It is especially difficult to decide which of two species is the more polymorphic when their allometry is complex and concerns different dimensions, and it is usually impossible to apply a simple statistical test in such a case. But where two species show the same type of allometry, as for instance in the broadening of the head, there is no reason why they cannot be compared directly. The degree of polymorphism of any species is a function of allometry and the range of the intranidal size variation. One index which is compounded of these two characteristics has been devised as follows:

$$\text{polymorphism index} = 100 \times \frac{v_2 - v_1}{m} \times |(k - 1)|$$

where $(v_2 - v_1)/m$ is the difference between the extreme measurements of the non-allometric dimension divided by their average and $|(k - 1)|$ is the absolute value of the equilibrium constant minus one. Such an index will have meaning only if a single organ of the body has marked allometry and the allometry is monophasic. It should prove expecially useful in comparing examples of feeble polymorphism across taxonomic groups and in descriptions of polymorphism within circumscribed taxonomic units. The indices of some representative polymorphic species are given in Table 1. In each case y = width of head across eyes, and x = maximum pronotal width. Those species with equilibrium constants between 1.0 and 1.1 have been assigned the constant 1.1.

TABLE 1

A comparison of the index of polymorphism in various species of ants

SPECIES	LOCALITY	k	POLY-MOR-PHISM INDEX
Eciton nigrescens (Cresson)	Tuscaloosa, Alabama	1.2	9.4
Solenopsis saevissima richteri Forel	Iguazu, Misiones, Argentina	1.1	4.6
Solenopsis interrupta Santschi	Tucuman, Argentina	1.1	6.9
Solenopsis geminata (Fabricius)	Mobile, Alabama	1.5	52.0
Camponotus castaneus (Latreille)	Knoxville, Tennessee	1.9	96.9
Lasius fuliginosus spathepus Wheeler	Odawara, Japan	1.1	1.5

THE ORIGIN OF THE WORKER CASTE

The queen and worker castes are differentiated in all taxonomic groups by complete dimorphism in the structure of the alitrunk (thorax-propodeum) and the abdomen. In a few species of higher ants, including members of the myrmicine genera *Leptothorax*, *Monomorium*, and *Formicoxenus*, the two castes are connected by a nearly complete, gradient series of intermediates. These upon analysis show diphasic allometry in the alitrunk (see Fig. 9) and abdomen (gaster) and monophasic allometry in the head. Other species, including members of the ponerine genus *Leptogenys* and the myrmeciine genus *Myrmecia*, show occasional intermediates which maintain the same pattern. If our assumption is correct that this secondary breakdown of the queen-worker segregation follows the original allometric path of connection, it is probable that the worker caste has been derived phylogenetically from the queen by the same mechanism which later divided it into subcastes. The lower segment of the diphasic thoracic and abdominal line yields a progression of forms which differ little in proportion from the worker castes of other ants, while the upper segment gives rise over a short size increase to typical queens or queen-like ergatogynes. This modification of allometry appears to be directed toward the stabilization of the smaller worker caste, which was at first derived with little size change from the fully developed queen.

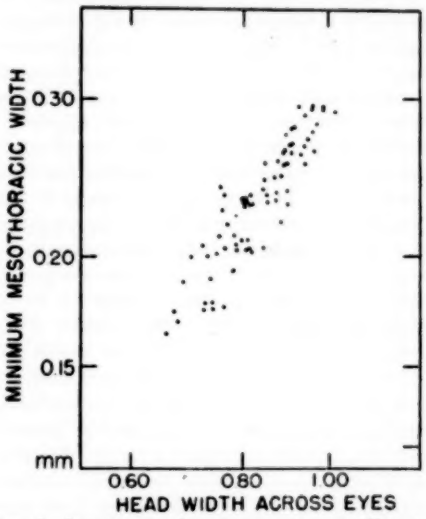

FIG. 8. INTERNIDAL ALLOMETRY IN THE WORKER CASTE OF A MONOMORPHIC FORMICINE ANT, PRENOLEPIS IMPARIS (SAY)

Log-log plot. Based on material from 45 localities over North America, exclusive of California and Oregon. Calculated maximum error, ± 0.006 mm.

The probable immediate result of the original queen-worker segregation can be seen in *Myrmecia*, considered with *Nothomyrmecia* to contain the most primitive of living ants. Here the queens are not much larger than the largest workers and are morphologically nearly identical to them except for the great development of the meso- and metathorax and consequent architectural effects on the rest of the alitrunk. Intercastes are common in this genus and with respect to the alitrunk fall along

the steep incline of the upper segment of the allometric curve connecting the two principal castes. The condition seen in the several myrmicine genera mentioned above can be considered to be a secondary adaptive modification, while intercastes in the genus *Myrmecia* appear to be exceptional and superimposed upon a strongly marked dimorphism.

An important aspect of the usual queen-worker differentiation which has thus far escaped proper attention is that the head does not participate in

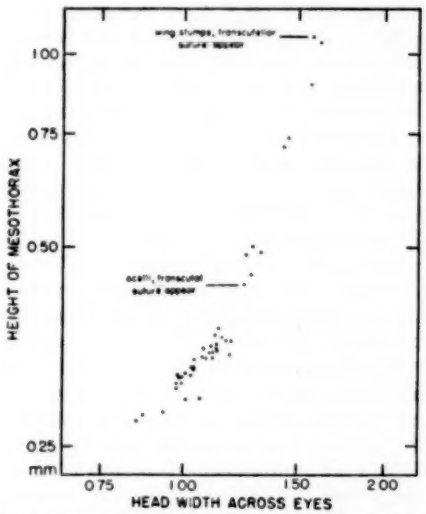

FIG. 9. DIPHASIC ALLOMETRY IN THE ALITRUNK SEEN IN QUEEN-WORKER INTERGRADATION IN MONOMORIUM CINCTUM WHEELER

Log-log plot. The lower segment of the regression line comprises the worker caste, while the upper segment comprises ergatogynes which range from worker-like forms to subapterous forms very close to the typical queen of related species. Based on the type series of *M. cinctum* and one series each from Ferntree Gulley and Lake Purrumbete, Victoria, W. L. Brown leg. Calculated maximum error, ± 0.006 mm.

the rigorous dimorphic segregation shown by the rest of the body, but tends to conform to worker allometry. This means that the shape of the head of the queen is such that various dimensions measured one against the other will fit an allometric regression line derived from those same measurements in the worker. Where the majors of a polymorphic worker series surpass in head-size the queen, the head shape of the queen is similar or identical to that of the media or major class with comparable head size. This is clearly shown in some very size-variable species such as *Orectognathus versicolor* Donisthorpe. Here the head of the queen approximates in size and shape that of a large media, and variability in size within the queen caste produces an allometric progression identical to that seen in the worker caste. A similar precise relationship is encountered in *Myrmecia*, which has basically polymorphic workers. It is also exhibited by various groups of the primitive subfamily Ponerinae (Amblyoponini—*Amblyopone*; Ponerini — *Paltothyreus*, *Odontoponera*, *Termitopone*, *Neoponera*, *Pachycondyla*, etc.) and in certain primitive Myrmicinae (Myrmicini—*Pogonomyrmex*). The relationship is only approximate in the higher Myrmicinae and in other subfamilies with polymorphic species. The queen shows obvious modifications surrounding the retention of fully developed eyes, her cephalic spination is often reduced, and her mandibles tend to retain the elementary worker dentition, which is aborted in the majors of many granivorous species. In some ants, especially those which show complete worker dimorphism, the head shape of the queen cannot be related in any way to that of the worker.

This peculiar cephalic bond occurring between the queen and worker defies physiological explanation at the present time. Allometry ordinarily is a relationship which can be drawn between any two parts or dimensions of the body, and the equilibrium constant is in theory most simply derived as the ratio of two specific growth rates. The queen-worker cephalic allometry clearly shows that relative growth of a different nature operates in ants. The alitrunk displays allometric variation which presumably has become diphasic and then dimorphic, although retaining the diphasic potentiality. The head has taken a different course, retaining monophasic allometry which is correlated with thoracic allometry only as this appears secondarily in the worker. This means that the various dimensions of the head which make up its shape and structure are actually related to the rest of the body only as this determines total head size and not as its constituent parts vary allometrically.

Yet even more extraordinarily, there remains one set of cephalic structures, the ocelli, which often varies directly with the body and independently of the rest of the head. All three ocelli are present and fully developed in all size classes of workers in *Myrmecia* and in a few other, scattered groups of ants, such as some Pseudomyrmicinae, the cerapachyine genus *Neophyracaces*, and many formicine genera. In most ants, however, the

queens possess the three ocelli and the workers possess only one (the median) or none. That this is not an allometric character related to the head is seen in certain polymorphic species which have majors surpassing in head size the queen. In these, including many *Pogonomyrmex*, *Messor*, *Orectognathus*, *Pheidole*, *Pheidologeton*, and *Camponotus*, the queen head shape fits approximately the worker regression lines, but the media and major forms around and above the placement of the queen in these lines possess at the most only one ocellus. The most logical conclusion which presents itself is that the two posterior ocelli develop because of an influence, perhaps hormonal, which somehow originates from the massive bulk of the queen's body. The occasional appearance of the median ocellus in the upper segment of the worker allometric series indicates that either the total size of the body or some part of the body behind the head is the determining factor. Furthermore, the appearance of all three ocelli in some physogastric ergatogynes ("ergatoids" of Wheeler) which have worker-like alitrunks and heads and distended ovarian abdomens, suggests that the ovaries may be the most important specific loci influencing the ocelli.

THE EVOLUTION OF WORKER POLYMORPHISM

Since queen-worker cephalic continuity is seen to be widespread in polymorphic ants, the possibility is now presented that the diffrences in proportion between the worker and queen may be a measure of the potential allometry of the worker caste, even in essentially monomorphic species. Three important pieces of evidence support this. First, in those groups of ants which are totally monomorphic and have no evident immediate polymorphic ancestors, such as the Ectatommini, Typhlomyrmicini, and Proceratiini among the ponerines, the differences in head shape between the queen and worker castes tend to be very slight. Second, in some species which show internidal, but not intranidal, cephalic allometry, the queen conforms to the worker regression lines exactly as do the queens of polymorphic species; examples include *Paltothyreus tarsatus* (Fabricius), *Neoponera villosa* (Fabricius), *Pachycondyla crassinoda* (Latreille), *Pogonomyrmex badius* (F. Smith), *Vollenhovia pedestris* (F. Smith), and *Crematogaster chasei* Forel. Third, in a few small groups such as the myrmicine genus *Wasmannia*, the queen-worker cephalic differences seen from species to species seem to be a positive function of the difference in head size.

The queen-worker cephalic difference, involving typically an expansion of the head and particularly of the occipital lobes, is a character found throughout nearly every major taxonomic group of ants. If the queen head shape is truly consistent with the worker allometry, as the evidence above seems to indicate, this means that the great majority of genera possess latent cephalic allometry to some degree. It follows that *internidal* allometric variation would result from the acquisition of genetic internidal size differences, and *intranidal* allometric variation (worker polymorphism) would result from the increase of the normal phenotypic size variability which is based on the limited genotype possessed by a single average colony. This is an extremely significant concept, because it could explain why and how worker polymorphism appears in so many groups of ants independently, and nearly always follows the same trends in each.

From species to species through the Formicidae the worker caste shows nearly every conceivable step in a transition from complete monomorphism to complete dimorphism. The major stages into which this transition can be divided have been defined previously. The succession of these stages and their potentiality for reversal as understood at the present time are represented in Fig. 10. The evidence for such a phylogenetic series has been drawn from analyses of a number of taxonomic groups which show variable polymorphism and different associations of the several stages. For purposes of illustration some of the more significant groups are briefly described below.

1. The Ponerini. This tribe exhibits all nuances from monomorphism to strong monophasic allometry. *Ponera*, *Mesoponera*, *Euponera*, *Ectomomyrmex*, *Bothroponera*, and other genera show absolute monomorphism and little queen-worker cephalic difference. *Plectroctena mandibularis* F. Smith, *Pachycondyla crassinoda* (Latreille), *Neoponera villosa* (Fabricius), and other genera and species show internidal, monophasic cephalic allometry but not true worker polymorphism. The cephalic allometry is expressed within individual colonies to produce polymorphism in *Termitopone laevigata* (F. Smith) and *Megaponera foetans* (Fabricius). In the latter species strong bimodality is developed, with the intermediates becoming relatively scarce.

2. *Pogonomyrmex*. This genus shows within its

species very concisely the origin of simple polymorphism. The majority of species are completely monomorphic, and some, including members of the subgenus *Ephebomyrmex*, show little or no queen-worker cephalic difference. Most of the members of the subgenus *Pogonomyrmex*, however, show in addition considerable queen-worker ce-

separate allometric regression lines, which in turn possess different equilibrium constants. In *P. rhea* Wheeler (Fig. 5) and *P. vasliti arizonica* Santschi the majors and minors appear on superficial examination to be connected by a complete series of intermediates. Analysis shows that actually the intermediates represent an extension of the major

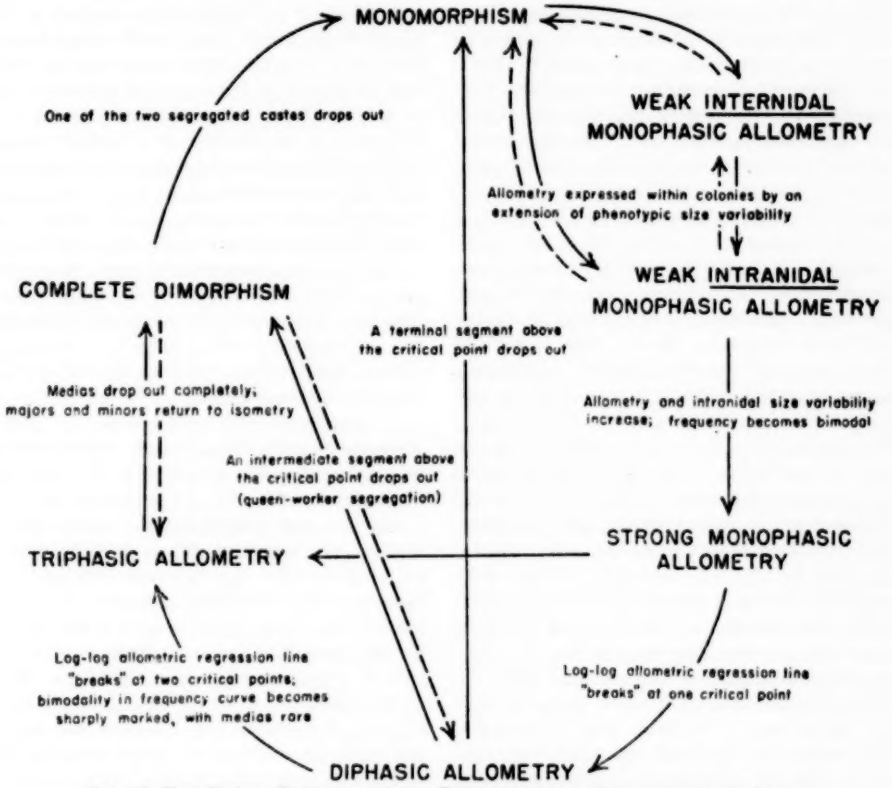
MONOMORPHISM
WEAK INTERNIDAL MONOPHASIC ALLOMETRY
One of the two segregated castes drops out
Allometry expressed within colonies by an extension of phenotypic size variability
WEAK INTRANIDAL MONOPHASIC ALLOMETRY
COMPLETE DIMORPHISM
A terminal segment above the critical point drops out
Medias drop out completely; majors and minors return to isometry
Allometry and intranidal size variability increase; frequency becomes bimodal
An intermediate segment above the critical point drops out (queen-worker segregation)
STRONG MONOPHASIC ALLOMETRY
TRIPHASIC ALLOMETRY
Log-log allometric regression line "breaks" at two critical points; bimodality in frequency curve becomes sharply marked, with medias rare
Log-log allometric regression line "breaks" at one critical point
DIPHASIC ALLOMETRY

FIG. 10. THE KNOWN PATHWAYS IN THE DEVELOPMENT OF POLYMORPHISM IN ANTS
Further explanation in the text.

phalic difference, and in a few species, such as *P. barbatus* (F. Smith), these differences can be demonstrated to be linked exactly with internidal, monophasic worker allometry. In at least two species, *P. badius* (Latreille) and *P. wheeleri* Olsen, the allometry is expressed within normal nest series, producing worker polymorphism.

3. *Pheidole*. This genus shows the intimate connection between triphasic allometry and complete dimorphism. Most species are completely dimorphic, with each of the two subcastes limited to

regression line to a point near the minor regression line. The minors, however, undergo no change and remain a segregated and size-limited group. If the major line were to be extended further down, it would by-pass the terminal point of the minor line; several intermediates found in the case of *P. rhea* indicate that the allometry is actually triphasic.

4. Miscellaneous genera of the pheidoline-myrmecinine-leptothoracine-etc. tribal complex. The genera composing this group, at present only imperfectly divided into tribes, run nearly the entire

gamut of polymorphism. Species of *Megalomyrmex* and *Huberia* are completely monomorphic, and only in the latter genus is there much queen-worker cephalic difference. *Vollenhovia pedestris* (F. Smith) shows internidal cephalic allometry in the worker but not true worker polymorphism. *Heteromyrmex rufiventris* (Forel) shows weak monophasic cephalic allometry expressed over a very great size range in a single colony. *Tranopelta subterranea* Mann and species of *Solenopsis* s. str. show relatively strong monophasic cephalic allometry over a fair size range and therefore are markedly polymorphic. The workers of *Monomorium* (*Holcomyrmex*) *criniceps* Mayr and *Solenopsis* (*Diplorhoptrum*) *robustior* Santschi, in the material which I have been able to examine, exhibit weak diphasic allometry over considerable size ranges. The worker castes of most of the species of *Solenopsis* (*Diplorhoptrum*), and possibly many of *Monomorium* also, are secondarily monomorphic, comprised of small individuals showing exceedingly little size variation and a form quite different from that of the queen. It is very possible that this condition has been derived from diphasic allometry of the type exhibited by *S. robustior* and *M. criniceps*, since it is only necessary to take away the upper segment of the diphasic log-log regression line to produce a worker caste similar to that of the monomorphic species. Extreme monomorphism, associated with small size and in some cases unquestionably derived secondarily from polymorphism, has been developed by several genera of the tribal complex and ordinarily for one or the other of two outstanding adaptive reasons. *Carebara*, *Carabarella*, *Liomyrmex*, and most *Solenopsis* (*Diplorhoptrum*) are thief ants, living in tiny galleries adjacent to the nests of larger species of ants or termites from which they steal food. *Allomerus*, probably *Xenomyrmex*, and some *Solenopsis* (*Diplorhoptrum*) live in the cavities of plants. Another, quite different trend which some genera have followed is the total loss of the worker caste through social parasitism on other ants. Examples include *Wheeleriella*, *Anergates*, *Epoecus*, and probably *Hagioxenus*. Finally, the parasitic genus *Epixenus* has apparently lost all female castes except for a worker-like ergatogyne.

5. The Dacetini. This tribe, which has recently been intensively studied by Brown (1953), is especially significant in that changes in polymorphism can now be correlated with generic phylogeny and partly with ecological evolution. According to Brown, dacetines can be divided into four basic stocks, the Dacetiti, the Orectognathiti, the Epopostrumiti, and the Strumigeniti. In each of these the primitive genera are polymorphic and usually epigaeic, and there is evidence to suggest that these features were derived from a common ancestor. Derivative genera have arisen in each which possess workers tending to be smaller, monomorphic, and hypogaeic (or at least cryptobiotic). In the genus *Strumigenys*, one species (*S. loriae* Emery) shows polymorphism of such extent that the major workers surpass in head size the queen. But the occurrence of this polymorphism is erratic, and it is often not expressed at all in smaller colonies. Furthermore, other *Strumigenys* and members of *Strumigenys*-derivative genera show monomorphism which gives the appearance of having been evolved from the kind of polymorphism seen in *S. loriae* by a suppression of intranidal size variability and a retention of only large medias with head size comparable to that of the queens. The association of monomorphism with a cryptobiotic mode of life in the Dacetini is illustrative of a trend common in ants.

6. *Camponotus*. This genus shows in gradual steps the transition from strong monophasic allometry to complete dimorphism. The majority of species show marked polymorphism based on strong allometry combined with considerable intranidal size variation; those which have been analyzed thus far also show some degree of bimodality. The bimodality increases, with intermediates becoming scarce, in a few species such as *C.* (*Myrmothrix*) *abdominalis floridanus* Buckley and *C.* (*Myrmobrachys*) *planatus* Roger. These upon analysis have shown what appears to be feeble triphasic allometry. Complete dimorphism has been attained several times independently within the genus, occurring in *C.* (*Tanaemyrmex*) *inaequalis* Roger (frequency data in Falconer Smith, 1943) and in species of the subgenera *Colobopsis*, *Pseudocolobopsis*, *Hypercolobopsis*, and *Paracolobopsis*.

DIVISION OF LABOR

The adaptive result of the development of female polymorphism is the division of labor within the colony. In many ants the queen and worker castes have assumed functions so different as to be almost mutually exclusive. In mature colonies the queens are ordinarily devoted entirely to oviposition and the occasional tending of the

brood; as recognized by Wheeler and others, they are functionally the female "germ cells" of the social organism. The workers, on the other hand, are concerned almost entirely with the labor of the colony, tending the brood, foraging, and excavating the nest. On occasion they may act as supplementary reproductives or may even usurp the ovipository function of the queen.

The division of labor which occurs within the worker caste is less distinct. Thorough studies by Buckingham (1911), Chen (1937), and Lee (1938) on *Camponotus* and by Doflein (1920) on *Messor* show that pronounced division of labor occurs in species with strong monophasic allometry, but the division is by preponderance only, and any worker is capable of performing any given normal task. It is possible for some degree of specialization to follow upon the slightest degree of intranidal allometry. It has long been known, for instance, that even in monomorphic species workers often differ in temperament and inclination to forage, and that this is especially pronounced between nanitic and normal-sized individuals. Chen (1937) has shown that within a given size class of *Camponotus* a leader-follower relationship is maintained which has some of the features of the "peck order" established in gatherings of many semisocial animals. This relationship shifts from day to day, but so slowly that the temperaments of the extreme individuals remain opposed to one another for long periods of time. It is not difficult to imagine, therefore, that slight morphological variability of the sort produced by cephalic allometry would cause behavioral variability. An actual division of labor in a weakly polymorphic species, *Formica rufa* L., has been recorded by Alpatov (1924), but otherwise borderline cases have received little attention from students of ant behavior.

Worker polymorphism in ants is a special adaptive condition which has been assumed by many different phyletic lines with various results. Although it is a signal feature of advanced insect societies, it does not have the general effect within the ants of increasing the complexity of social organization, and it is not an advanced phylogenetic character, since it is possessed to a marked degree by *Myrmecia* and occurs commonly in the primitive subfamilies Ponerinae and Cerapachyinae. Similarly, it does not necessarily confer selective superiority over competing monomorphic species. It should be emphasized that *Iridomyrmex*, the most abundant ant of the Baltic Amber, and *Crematogaster*, probably the most rapidly expanding genus of modern times, are both eminently monomorphic. Also, primarily monomorphic genera such as *Myrmica*, *Formica*, *Monomorium*, *Leptothorax*, and *Tetramorium* are today among the outstanding dominants among ants in various parts of the world. In general, polymorphism clearly operates to apportion among morphological specialists the labor which must be performed by any ant colony, polymorphic or monomorphic, which occupies the same general ecological situation. In intermediate stages of polymorphism, a common situation is one where the majors are primarily concerned with defense and nest excavation, the medias with the majors are primarily concerned with foraging, and the minors are primarily concerned with care of the brood. The principal result of extreme polymorphism, involving triphasic allometry or complete dimorphism, is typically the production among the castes of a major form especially and elaborately constructed for one or a very limited number of tasks. For instance, the majors of *Pheidole* have enormously enlarged heads and serve in many species as meat trenchers or seed crackers for the colony. The major of *Cataglyphis bombycina* Roger is most active in nest excavation; it has greatly elongated mandibles which work in conjunction with the maxillary palps in carrying large pellets of sand (Bernard, 1951). Perhaps the most extraordinary specialization of this type is seen in the dimorphic species of *Paracryptocerus* and *Camponotus* (*Colobopsis*, etc.), the majors of which have shield- or plug-shaped heads used in blocking the nest entrances against invaders (see, e.g., Kempf, 1952).

It would be appropriate at this point to stress that feature of social polymorphism which makes it truly unique in organic evolution. This is its function in differentiating forms with regard to their contribution to the selective value of the colony as a whole but without regard to their selective values as individuals. Social polymorphism is thus strongly distinguished from other types of polymorphism, including the genetic, which are maintained in populations because of the selective advantage they confer on individuals. In terms of evolution, the following analogy can properly and instructively be drawn: the ant colony behaves as a superorganism, the basic unit upon which natural selection operates, and polymorphism, originating from allometric growth series, acts as the

"morphogenetic" process underlying the somatic differentiation of this superorganism. Worker polymorphism is an advanced stage of the somatic differentiation which can be readily assumed or reduced according to the immediate needs imposed by the environment.

A PHYLOGENETIC CONSPECTUS

Worker polymorphism has arisen many times in the phylogenetic history of the Formicidae, possibly originating through the simple mechanism of the extension of intranidal size ranges of internidally allometric species. During the present survey the condition has been encountered in every subfamily with the exception of the Leptanillinae and Pseudomyrmicinae. It occurs in some species of at least a fourth of all ant genera recognized at the present time. Despite the uncertainty and confusion in our present knowledge of ant phylogeny, it still can be safely said that worker polymorphism has appeared independently in a minimum of eight major taxonomic groups. It occurs as a primitive character in *Myrmecia*, in the Dorylinae, and possibly in the ponerine tribe Amblyoponini, and it is found sporadically through the Cerapachyinae and Odontomachinae. It appears again in the ponerine tribe Ponerini. Most members of the subfamily Ponerinae are absolutely monomorphic, with little queen-worker cephalic difference, and this character is carried through the tribe Ectatommini to their probable derivatives, the myrmicine tribe Myrmicini. Within the Myrmicini, at least two species of *Pogonomyrmex* have developed worker polymorphism again. In the Myrmicinae past this group, the Myrmicariini, the Crematogastrini, and the extensive pheidoline-myrmecinine-leptothoracine tribal complex all show polymorphism of variable degree. Many of the genera in these groups contain both monomorphic and polymorphic species, and the internidal-intranidal allometry transition, or its reverse, is clearly operative. Worker polymorphism has appeared at least twice, and possibly three times, in the subfamily Dolichoderinae, occurring in *Tapinoma*, *Azteca*, and *Zatapinoma*. *Aneuretus* and the tribe Dolichoderini, considered the most primitive dolichoderines, are both monomorphic and show little queen-worker cephalic difference. Polymorphism appears as an elementary character in the section Alloformicinae of Emery, comprising the most primitive genera of the Formicinae. Many of the members of the more advanced section Euformicinae are also primarily polymorphic, but the character has very likely arisen again secondarily in the genus *Formica*.

Complete dimorphism is a distinct and easily recognized condition which has evolved, without question independently, in the following nine genera: Myrmicinae — *Ischnomyrmex*, *Pheidole*, *Pheidologeton* (?), *Oligomyrmex*, *Acanthomyrmex*, *Paracryptocerus;* Dolichoderinae — *Zatapinoma;* Formicinae—*Camponotus* (*Tanaemyrmex*, *Colobopsis*, etc.), *Pseudolasius*.

SUMMARY

The preponderance of evidence at the present time indicates that in ants sex is determined by the genetic mechanism of haplo-diploidy and the female castes are determined by larval nutrition. In the case of complete dimorphism of the female castes, as in queen-worker and major-minor segregations, there probably exists a critical developmental time at which the imaginal discs assume one or the other of two alternative specific growth-rate potentials, depending on whether or not the larva has reached a certain threshold size. Past the critical time, the larva starts along a more or less regulated trend of growth and at the prepupal stage metamorphoses into the essential form of the adult caste predetermined by the imaginal disc potentials. In incomplete dimorphism, whether in the more primitive types of worker subcaste differentiation or in the rare cases of queen-worker intergradation, the females form a gradient series which exhibits simple or modified allometry. For this reason polymorphism is here defined in terms of allometry, and its lower limits are set as follows: allometry occurring over a sufficient range of size variation within a normal mature colony to produce individuals of detectably different form at the extremes of the size range.

The trend of the evolution of worker polymorphism in most phyletic lines is first toward allometric differentiation along a gradient size series and second toward dimorphism, or the segregation of two extreme size groups with the elimination of intermediates. Several successive phylogenetic stages between monomorphism and dimorphism, characterized by correlated changes in the frequency and log-log allometric curves, have been encountered repeatedly. Dimorphism is preceded by a "breaking" of the allometric curve

at one or two points; in the latter case the resultant middle segment corresponds to the deepening trough of the bimodal frequency curve. Dimorphism is finally attained by an elimination of the middle segment (the media subcaste) and a return of the terminal segments (the major and minor subcastes) to isometry.

The worker caste probably arose from the queen by the same mechanism. Queen-worker intergradation shows diphasic allometry in the alitrunk (thorax-propodeum) and abdomen, and monophasic allometry in the head. There is a tendency for the head to conform to secondarily acquired worker allometry, even after the rest of the parts of the body have become completely dimorphic.

With the restriction of the concept of the caste to normal, functional forms and an acceptance of the allometric background of polymorphism, a considerable simplification of the terminology of polymorphism can be introduced. Only ten morphological forms are recognized here as being distinct castes: the male, the ergatomorphic male, the queen, the worker (consisting in worker-polymorphic species of major, media, and minor subcastes), the typical ergatogyne, the physogastric ergatogyne, and the dichthadiiform ergatogyne.

The differential growth underlying at least the gross features of polymorphism in adult ants must occur during the brief period of the proliferation and deployment of the pupal hypodermis before the last larval ecdysis. Lesser details of allometry may become apparent only at the onset of adult development within the pupa.

The adaptive significance of polymorphism lies in its apportionment among morphological specialists of the labor which must be performed by any ant colony occupying a similar ecological situation. However, worker polymorphism is not an advanced phylogenetic character, it does not have the general effect of increasing the complexity of social organization, and it does not necessarily confer selective superiority over competing monomorphic species. It is a special adaptive character which has arisen independently in a minimum of eight major taxonomic groups and has resulted in various types and degrees of division of worker labor. In many cases it has probably started from the simple mechanism of an internidal-intranidal allometry shift, which is effected by an increase in the size variability of individual colonies. Worker dimorphism has evolved independently a minimum of nine times. It usually has the adaptive result of producing among the castes a major form especially and elaborately constructed to perform one or a very limited number of tasks.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to several individuals for aid given during the course of this study. Drs. W. L. Brown, W. J. Crozier, and C. M. Williams reviewed parts of the manuscript and original data and offered excellent criticism and additional information. Mr. W. J. Cloyd, and Drs. A. C. Cole, A. Van Pelt, and R. E. Gregg supplied from their own collections some of the most important nest series used in the study.

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NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will occasionally appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not received it. All material for notice in this department should be addressed to H. B. Glass, Associate Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

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GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

THE NEGLECT OF SCIENCE. *Essays Addressed to Laymen. By F. E. Simon. Basil Blackwell, Oxford.* 8s. 6d. vi + 138 pp. 1951.

Britain is a manufacturing nation, and her past wealth and influence stemmed, in part at least, from the political domination which gave her a ready and world-wide market for her finished products. The technology of the day, bolstered by the prestige of the British lion, was sufficient to hold these markets, but now that darker prospects are in store for Britain, and her former sources of revenues are being lost to more competitive and technically advanced nations, it is, according to the author, imperative that Britain's "traditional neglect of science" be speedily remedied to provide the backlog of fundamental ideas and facts upon which an aggressive and profitable technology feeds. Dealing with his topic first in general terms, Simon considers that the average British scientist is capable of first-rate research, as indeed he is, but that British industry, through cartelization and diminishing enterprise, has failed to keep pace with the United States, Germany, and Switzerland. He then traces this decline by considering, in turn, the educational system, the industrial research laboratories and the policies which guide them, the salaries of research men, and the public attitude toward research, at the same time contrasting Britain with other nations, notably the United States and Russia. Recognizing that science rather than technology now forces the pace, the author sees a partial solution for his country through the continued development of the operational type of research which proved so successful during the past war. He favors this in the universities rather than the German idea of a laboratory subordinated to the glory of the single leader, or the American idea of independent and uncoordinated research carried on by individuals. The United States emerges, by way of contrast, technologically rich and powerful, but spiritually shallow and scientifically (i.e., fundamentally) improvident, despite the intellectual drain it has made on the European scientific community. Indeed, the author has a very low opinion of practically everything American, and he warns his English public that salvation (by this I think he means a place in the sun) cannot be attained by attachment to the American bandwagon, since it is headed at a breakneck pace for disaster.

In a more practical vein, the remainder of the book

deals specifically with Britain's fuel problem (here the author exhibits less prejudice and probably more competence, since he is a physicist), and in general with such topics as atomic energy, isotopes, and electronic brains. The last two chapters, one on feeding the world population and the other on accuracy, are ramblings of no consequence. The first three chapters are excellent and might well be studied by our directors (particularly our military directors) of research who, by dangling the lure of research money beneath the noses of investigators, have done much to divert our intellectual strength into channels of expediency rather than of fundamental worth. The remainder of the book can be taken or left without gain or loss. The querulous tone of writing, mingled with curious overtones of belligerence and pride, is suggestively indicative of a nation which finds itself on its "uppers," and greatly resents its present position.

C. P. SWANSON

BIOLOGY: *Its Human Implications. Second Edition. By Garrett Hardin; Illustrations by Evan L. Gillespie. W. H. Freeman and Company, San Francisco.* $5.00. xii + 720 pp.; ill. 1952.

The first edition of this college biology textbook was at once received with universal note of its original and stimulating character. The illustrations were unusually graphic and always got the point across, but they displeased some teachers, and even some students, because they sometimes resembled cartoons or drawings like those used in elementary education. College students, it was thought, should resent this affront to their mature dignity. The text was subject to a different type of criticism, that of unusual organization and selection of material. In some cases the result was undoubtedly good; in others, as in every original effort, undoubtedly mistaken. The merits of the textbook far outweighed its defects. Nevertheless, after trying it in use for a year, many teachers were unable to cope with the difficulties it presented.

From both points of view, but particularly as regards the reorganization of the text, the second edition is a vast improvement over the first and should rapidly reestablish itself in general favor. The graphic style of illustration has been retained, but the diagrams most criticized have been replaced. As for the text, the material on the cell and cell division, as well as introductory biochemical concepts, has been placed at the beginning; the second part, chiefly human anatomy and physiology, is much more unified and less interrupted by digressions and extraneous material; the treatment of heredity has been extensively revised and brought up to date, making it quite outstanding; and the section on evolution has been reorganized, with the survey of the plant and animal kingdoms following and illustrating the exposition of evolutionary principles. The final part of the book deals with ecological concepts.

A few criticisms seem still to be in order. The chapter on the Origin of Life failed to get moved along with the rest of the evolutionary topics to the preceding part of the book. The treatment of the historical aspects of evolution is still greatly underemphasized, and is not integrated with the survey of the plant and animal kingdoms. Hence the supposed evolution of plants and animals in Part Four of the book deals only with present-day organisms. Most serious of all, in my estimation, is the failure to bring together the general physiological concepts at an early enough point in the book to permit them to permeate the thinking of students for a major portion of the year. Photosynthesis is treated mainly in Chapter 29, and the matter and energy cycles in Chapters 36 and 37. It would seem highly advisable to introduce some of this subject matter in Chapters 3 and 4.

Regardless of such criticisms, this is a stimulating textbook, its defects being those of unconstrained originality. Far better a book like this than the dull, overloaded compendia of morphological and taxonomic detail that still—heaven knows why—are so widely used, particularly in standard botany or zoology, rather than biology, courses.

BENTLEY GLASS

MAN AND HIS BIOLOGICAL WORLD. *Revised Edition. By Frank Covert Jean, Ezra Clarence Harrah and Fred Louis Herman; with the editorial collaboration of Samuel Ralph Powers. Ginn & Company: Boston, New York, Chicago, Atlanta, Dallas, Columbus, San Francisco, Toronto, and London.* $5.00. viii + 631 pp. + 1 pl.; text ill. 1952.

This college science-survey textbook (see *Q.R.B.*, 20: 81, 1945) is the authors' attempt to meet the "necessity for change in our general-science educational procedures." They feel that a good textbook (1) should be a good source book; (2) should include material . . . related to the instructional problem but not necessarily pertinent to its solution; and (3) should be interesting. This revision aims to bring the book up to date, to correct such inadequacies as have been revealed through use, and to give further expression to the authors' evolving ideas of what such a textbook should be.

The text is organized around 9 units, subdivided into 23 chapters. The main units are: Life, "residing in protoplasm," Must Have Food; Reproduction; Adjustment and Behavior; Nature and Control of Disease; Metabolism; Adaptations and Modern Man's Disturbing Influence; Evolution; Genetics; and Man's Cultural Development, now Accelerated by Science and Invention.

The book is interesting and highly readable. Its

emphasis on the applications of biological principles to human living is a strong feature. From the strictly scientific point of view, the book has disturbing features: considerable teleology, a presentation of eugenics that is not entirely in accord with the viewpoint of the modern geneticist, at least a suggestion of vitalism (viz., "Life resides in protoplasm"), at least a hint of the inheritance of acquired characteristics (viz., "Living things have evolved in response to a changing environment"), and others. Perhaps the most unscientific feature of all is the statement, "Darwin's theory of evolution has been overthrown." In the hands of a teacher who can counteract the effects of these unscientific aspects, this textbook should prove stimulating.

ELLA THEA SMITH

THE SCIENCE OF BIOLOGY. *Fourth Edition.*
By William C. Beaver. The C. V. Mosby Company, St. Louis. $5.85. 895 pp.; ill. 1952.

Like the previous editions (*Q.R.B.*, 22: 60. 1947), this book carries a heavy load of terminology and factual material, so that it is almost encyclopedic. The author says, "A text book is not intended to be a book of entertainment. . . . The joy and entertainment come from scientific discovery of new facts and phenomena. . . ." The new edition differs from the preceding ones in that additions, deletions, and rearrangements have been made "in the light of the needs in various courses as presented." Chapter 6, The Properties and Activities of Living Protoplasm, lays the foundation for an understanding of the growing importance of biochemistry and biophysics in modern biology.

Certainly this is not an easy nor an "entertaining" textbook, but it should serve as a valuable reference book for those interested in stimulating students to do thorough work and to enjoy discovery rather than easy reading.

ELLA THEA SMITH

NEW BIOLOGY 12.
Edited by M. L. Johnson and Michael Abercrombie. Penguin Books, Melbourne, London, and Baltimore. 50 cents. 128 pp. + 8 text pl.; ill. 1952.

Contents: Variation (J. B. S. Haldane); A Skin Grafting Problem in Cattle Twins (R. E. Billingham); The Mode of Action of Copper Fungicides (R. L. Wain); Octopuses in the Channel (W. J. Rees); Biochemistry and Bacteria (J. Perret); Two Contributions to the Study of the Origin of Life: 1. Geochemical Aspects of the Origin of Complex Organic Molecules (V. M. Goldschmidt); 2. Vital Blarney (N. W. Pirie); The Mode of Action of the Heart in the Frog (G. E. H. Hoxton).

NEW BIOLOGY 13.
Edited by M. L. Johnson and Michael Abercrombie. Penguin Books, Melbourne, London, and Baltimore. 50 cents. 128 pp. + 8 pl.; text ill. 1952.

Contents: Can Wild Animals Be Kept in Captivity? (H. Spurway); Polyploidy and Plant Breeding (M. S. Swaminathan); The Analysis of Human Skill (R. C. Oldfield); The Thyroid Gland—a Study in Comparative Physiology (E. J. W. Barrington); The Bed-bug (C. G. Johnson); Famous Plants-3, *Mucor* (H. Tristram); Notes on P. Medawar's Article 'Problems of Adaptation' (P. B. Medawar; R. F. Ewer); Keep off the Grass (J. D. Bernal).

THE WORKS OF GEORGE BERKELEY, BISHOP OF CLOYNE. *Vol. IV.*
Edited by A. A. Luce. Thomas Nelson & Sons, London and Edinburgh. 30s. viii + 264 pp. 1951.

Of less interest to biologists, even the philosophically inclined, than the 3 preceding volumes in this definitive edition, the present volume contains *De Motu* with an English translation; *The Analyst*; A Defense of Free-Thinking in Mathematics, Of Infinites, and some other mathematical writings; Letters on Vesuvius, on Petrifactions, and on Earthquakes; and a Description of the Cave of Dunmore.

BIOLOGY: HISTORY AND BIOGRAPHY

THE LIFE OF GEORGE BERKELEY, BISHOP OF CLOYNE.
By A. A. Luce. Thomas Nelson & Sons, London, Edinburgh, Paris, Melbourne, Toronto, and New York. 25s. xii + 260 pp.; ill. 1949.

This year, 1953, is the bicentenary of Berkeley's death, and it is fitting indeed to remember him. No philosopher of the 18th century, perhaps, spoke with a more modern insight worthy of our attention; and no biographer could be better chosen than A. A. Luce, the scholar who has so devotedly edited the definitive edition of Berkeley's works with which the present volume agrees in format.

The *Life* is an account of Berkeley's years of education, ministry, visit to America, and writing, rather than an intellectual history. The final chapter contains, however, a superb appraisal of the man and his significance.

"Berkeley denied material substance on rational grounds; and to do so was a great and a philosophical achievement, as all philosophers must admit. He could do so only because he saw the perceptual situation clearly. Aristotle fogged that situation by introducing into it material substance or *matter* . . . , and Berkeley has told us with clarity, force,

and exhaustive thoroughness that we must drop Aristotelian *matter*, if we are not to falsify speculative knowledge at the entrance gate."

"Why is Berkeley's memory fresh and green after two hundred years? . . . There is a touch of the universal and necessary in Berkeley's life and thought which raises both above contingencies of time and place. He climbed high and saw far, and he stands apart and does not date. . . . He put truth first, and his intellect, will, and heart were in tune with truth. He received five talents, and he made them ten. He loved God and man and Church and country, and he could bow his head and kiss the rod. The stamp of the universal is upon the man and upon much of his work; and hence the widespread and continuing appeal of his life and his thought."

BENTLEY GLASS

THE GROWTH OF SCIENTIFIC IDEAS.

By William P. D. Wightman. Yale University Press, New Haven. $5.00. xii + 495 pp. + 8 pl.; text ill. 1951.

Few if any histories of science have adopted a more thought-provoking approach than this one, which undertakes to trace, as its title indicates, the history of ideas. Wightman speaks of his book as a preliminary essay, a "preparation for the study of the History of Science." The method of treatment is to study the "development of scientific thought as illustrated by a few dominant ideas," by fairly lengthy citations to bring the reader into "more intimate contact with the minds of the great discoverers," and thus to pursue a method "intensive as to problems, extensive as to background." Wightman further remarks in his Preface that he has "tried to avoid any special pleading. Thus while I admit wholeheartedly," he says, "our debt to such writers as Crowther, Farrington, and Hogben, I feel that the balance has swung too far in the direction of regarding the socio-economic as the sole directive in the cultural advance. I have tried as far as possible to take the record as I have found it, neither failing to emphasize the connexions where they seem particularly instructive, nor seeking them where other factors seem more important. Lest the story should seem colourless, I have enlivened its course with such biographical detail as seemed appropriate." With this judicious attitude is combined a belief that a critical historical study of science will provide a better understanding of scientific method than any abstract discussion of that difficult subject.

The book is in two parts: Matter and Motion the first; Nature and Life the second. The former, so far as a biologist can judge, is most admirable. The second part maintains the approach and stimulating quality of the first part; but less familiarity with the subject matter leads here and there to error. The chapters on Greek biology and the dawn of modern biology in the 16th and 17th centuries are excellent; but the development of cell theory is inaccurate and too traditional. Lamarck and Dutrochet go unmentioned, all begins with Schleiden and Schwann and Brown, dates of the discovery of mitosis are in error, and the beautiful collaboration of many eyes and many minds in unravelling this central biological process is narrowed down to Strasburger and Flemming, with later assistance from Waldeyer, Boveri, and Golgi. The chapter on evolution also seems poorly balanced, and ends with the amazing conclusion that "the 'origin of species' was a comparatively unimportant and rather faulty by-product of a transvaluation of all biological values." This sweeping disposition of the theory of natural selection, today so strongly developed in the modern genetical theory of evolution, may perhaps be only an echo of Nordenskiöld; but coming from a fellow-countryman of Fisher, Haldane, Darlington, Hogben, and other notable exponents of evolutionary process, it is astonishing indeed. The chapter on the repercussions of Darwinism gives chief place to Haeckel and Hofmeister. The two last chapters in the book, The Inside Story of Life, and Continuity and Organization, reveal a thoughtful approach but a weak development and denouement. Claude Bernard, Pasteur, and Johannes Müller fare better in the former than De Vries, Mendel, and the experimental embryologists in the latter. It is a great pity that the book, which starts out so bravely, ends up so lamely. It might have been better had the author stuck to the physical sciences; or else if he had made some effort to study modern biological concepts intensively before he endeavored to write the biological part of the book.

Be that as it may, this is surely the right way to go at the study of the history of science, for its deeper meaning lies in the history of *ideas* and *concepts* even more than in discoveries. To Wightman we remain indebted for his bold conception and pioneering execution.

BENTLEY GLASS

JOURNEYS AND VOYAGES TO NATURE. *A Survey of One Hundred Books.*

By J. Christian Bay. The John Crerar Library, Chicago. $2.00. 67 pp. + 2 pl. 1951.

Literary bibliography is a genre in which the author's taste (and at times, his whim) is final arbiter. If he leaves out what the reader thinks should have been included, it becomes a matter of personal difference rather than grounds for critical judgment. Bay has listed most of the great naturalists' journeys, has quoted liberally from several of them, and has succeeded in writing a guide to this literature from the

viewpoint of an intelligent lay reader. Professional naturalists who would like to see such a survey based more on the factual content of these books than on their literary qualities are welcome to assemble their own reading lists. (But how could Mr. Bay leave out our fascinating friend Charles Waterton.)

JOEL W. HEDGPETH

JOURNAL OF RESEARCHES INTO THE GEOLOGY AND NATURAL HISTORY OF THE VARIOUS COUNTRIES VISITED BY H. M. S. BEAGLE. *Facsimile Reprint of the First Edition, (1839).*

By Charles Darwin. Hafner Publishing Company, New York and London. $7.50. xiv + 615 pp. + 16 pl.; text ill. 1952.

Few volumes will afford the biological book collector greater pleasure than this facsimile reprint of the first edition of the *Voyage*. It is attractively bound, and in addition to the text, which has been reproduced by photo-offset, the publishers have included 16 of the interesting and seldom seen plates from the *Narrative of the Surveying Voyages of His Majesty's Ships Adventure and Beagle*, by Captains King and Fitz-Roy. When the student of Darwin's life and thought has placed this work on his shelf, beside a copy of one of the beautiful illustrated editions later brought out by John Murray, along with the recently edited letters and notebooks compiled by Lady Barlow, and the *Life and Letters*, his collection for a consideration of the background of the *Origin of Species by Means of Natural Selection* will be essentially complete.

BENTLEY GLASS

OTTO FRIEDRICH MÜLLER'S ZOOLOGIA DANICA. *Library Research Monographs, Vol. 1.*

By Jean Anker. Ejnar Munksgaard, Copenhagen. Dan. Kr. 12.00 (paper). xiv + 108 pp.; ill. 1950.

This series is off to a fine start with its first volume, which includes not only the history of a great zoological work but an examination of the philosophical setting of the times and a sketch of the life of O. F. Müller together with details about Müller's library and his contemporaries. The illustrations include portraits of Müller and his contemporaries and reproductions of plates from the *Zoologica Danica*. The inclusion of a list of the species described and figured in that work, together with their current names, enhances the value of this study to systematic zoologists. Much remains to be done in the field of 18th Century bibliography, and this work has set a high standard for those who turn to examine such authors as Marsigli, Bohadsch, and Donati, among others.

JOEL W. HEDGPETH

BERNHARD EDUARD FERNOW. *A Story of North American Forestry.*

By Andrew Denny Rodgers III. Princeton University Press, Princeton. $7.50. 623 pp. + 1 pl. 1951.

As the title implies, this book is not only a biography of Fernow, but a remarkably detailed account of the early history of forestry in North America. From the time of Fernow's arrival in this country from Germany in 1876 until his death in 1923, forestry developed in the United States and Canada from what at the beginning was essentially a propaganda movement to a profession of respected standing. Intimately associated with this development was the indefatigable and enthusiastic scientist, organizer, consultant, speaker, correspondent, and traveler who forms the subject of this book. Rodgers' account of Fernow's life and work is obviously based on exhaustive research, and is thoroughly documented by reference to the voluminous records of contemporary journals and numerous unpublished papers. Although the subject matter may have limited appeal to biologists in general, this book will doubtless be read with interest and profit by botanists and foresters with an historical bent.

SCOTT S. PAULEY

DAVID STARR JORDAN. *A Bibliography of His Writings 1871–1931. Stanford University Publications, University Series, Library Studies, Volume 1.*

Compiled by Alice N. Hays; with a personal appreciation by Robert E. Swain. Stanford University Press, Stanford, California; Geoffrey Cumberledge, Oxford University Press, London. $4.00 (paper). xi + 195 pp. 1952.

David Starr Jordan was a prolific writer. This classified and indexed bibliography lists over 1700 articles, books, poems, and lectures dealing with his work as naturalist and explorer, as teacher and college president, and as a "prophet of democracy" in the field of international relations. The ichthyologist will appreciate the arrangement of the papers on fishes in both chronological and alphabetical orders.

UN PIONNIER DE LA PHYSIOLOGIE, LÉON FREDERICQ. *Œuvres Choisies.*

With comments by Z. M. Bacq, M. Florkin, and H. Fredericq. Sciences et Lettres, Liège. Belg. Fr. 200. 232 pp.; ill. 1953.

The continuously increasing number of papers and communications in the biological sciences makes it increasingly difficult to keep abreast of current work even in a limited field. A meticulous investigator in a given field would have but little time for his own investigations were he to read, digest, and understand not only

the contributions which have met the editorial criterion of "original" but also the reviews, both the annotated bibliographies and the critical and synthetic discussions which nowadays appear so essential. Such a meticulous investigator would, however, eventually encounter a few volumes of the type described below: a reprinting of original contributions to knowledge made some 25 to 75 years ago. His efforts would then be repaid; at the least he would obtain a better perspective of his own work and of that of others.

Admittedly, the present volume was published for another purpose: that of commemorating the 100th anniversary of the birth of Léon Fredericq, one of the founders of modern physiology. The first section presents the speeches made at the commemoration ceremonies held in Liège on March 21, 1952. There are a number of reminiscences and biographical sketches, together with appreciations of Fredericq as a scientist and human being. In the following sections the scientist's major contributions are reprinted in part or in full, with an occasional commentary by Marcel Florkin or Z. M. Bacq. Articles on the heart and circulation are followed by studies on the control of respiration and on temperature regulation. There are two articles on vertebrate biochemistry. One deals with the plasma proteins; the other, reprinted in full, is the classical work on pulmonary gas exchanges. Bohr had suggested that the pulmonary epithelium played an active role in the transport of the gases. Fredericq's more refined experiments indicated that diffusion was the mechanism involved: a gas moves from the region where its partial pressure is higher to the region where its partial pressure is lower. The next section is on Comparative Biochemistry and Physiology: hemocyanins in the octopus and the lobster; the relationship of the external environment to the electrolyte composition of the body fluids of aquatic species. Another section is on Fredericq's studies of the flora and fauna of the plateau of the Baraque-Michel in the Ardennes.

This volume will particularly interest physiologists and biochemists and should serve as a reminder not only of the particular contributions of Fredericq but also of the origin of many fundamental physiological concepts.

F. CHINARD

A HISTORY OF NEUROLOGICAL SURGERY. *Edited by A. Earl Walker. Williams & Wilkins Company, Baltimore.* $12.00. xii + 583 pp.; ill. 1951.

Perspective is of key value in virtually any field of human endeavor, especially in medicine with its avowedly high standards. Neurological surgery was expected, largely as the result of Harvey Cushing's well deserved prestige, to be much above the general level. Without some knowledge of his antecedents, today's neurological surgeon would surely be deficient in such perspective. This book, unlike contemporaneous attempts of the sort by other authors, admirably portrays the specialty in depth. It is an ambitious work by 12 contributors and with nearly 500 references.

As one might expect from a work by many authors, the quality is somewhat uneven. Much of the book amounts to little more of literary value than a mere tabulation of events. These are often so subdivided under different headings, as, for example, the various technical procedures in brain surgery, that they appeal little to any but a neurosurgeon or perhaps a professional medical historian pursuing monographic studies. The intended audience is not designated by the authors, and perhaps no wider one is expected. One would hope, however, that so complete a work would enjoy wide reading. A better style of story-telling might have assured this. Some chapters lack a current evaluation of past procedures and concepts. Thus, no remark is made concerning Horsley's fear of cutting veins leading from the frontal lobe to the sagittal sinus; yet now every neurosurgeon will without hesitation sever these veins anterior to the motor strip. This criticism, however, cannot be leveled at Walker's chapter on craniocerebral trauma. Here and elsewhere a maturer evaluation is discernible, due, no doubt, to a riper experience in authorship.

Of particular value is the forcible bringing to mind of "old" procedures surprisingly similar to, or even identical with, "new" methods currently being popularized. This is especially true with reference to hydrocephalus but also to the use of wire for spinal fusion. It is particularly good to read of discarded therapies and the reasons therefor. Much time and effort is saved when one is thus prevented from reviving old, outmoded concepts that inevitably arise anew in each generation.

Basically the book is divided into 3 parts: first, the histories covering the various aspects of neurological surgery—by far the bulk of the volume; second, the biographies of leading neurosurgeons of the past; and, finally, excerpts from classical writings in neurological surgery. The last are fortunately minor in amount, for one cannot help feeling that there is little relationship between the meaning conveyed to the reader by these excerpts and that enjoyed by the author who saw it in context. The biographies are for the most part excellent, and the accompanying photographs are very much alive. This history can unhesitatingly be recommended for the neurological surgeon and the neurologist, as well as for any reader whose sympathies lie with the story of human groping toward better health.

STANLEY STELLAR

THE ENGLISH PIONEERS OF ANAESTHESIA. (*Beddoes, Davy, and Hickman*).

By F. F. Cartwright. The Williams & Wilkins Company, Baltimore. $4.50. x + 338 pp. + xix pl. 1952.

Many volumes have been published on the history and discovery of anesthesia. Most of these embrace the dramatic use of nitrous oxide, ether, and chloroform by Wells, Morton, Long, and Simpson. This interesting volume provides the background experimentation and study in the half century 1800–1850 that antedated the discovery of surgical anesthesia.

In this period the English investigators Henry Hill Hickman, Thomas Beddoes, and Sir Humphrey Davy played a stellar role. The author gives an interesting and authentic picture of English life in the early part of the 19th century. The rise of pneumatic medicine and Beddoes' heroic efforts to promote the use of inhaled gases to treat various diseases are described in great detail. Interesting integrations of this activity with the work of Lavoisier are discussed. To Beddoes is given the credit for the advocating of the use of the inspired air as a means of medication.

The early experiments of Hickman on the inhalation of carbon dioxide and the production of unconsciousness are delineated in great detail. Many interesting personal episodes and contacts are recorded by the author, such as the interest of James Watt, the discoverer of steam, and Erasmus Darwin, the grandfather of Charles Darwin, in the experiments in pneumatic medicine.

The volume also speaks about the work of Sir Humphrey Davy and his use of nitrous oxide on himself and on other individuals. The character of Sir Humphrey is exquisitely delineated.

Outstanding in this volume is the emphasis that during this period when these pioneers in the field of anesthesia were at work, a concomitant change in man's attitude to suffering was taking place, which highlighted the advent of the discovery of anesthesia.

The book is to be highly recommended for felicity of style and its excellent insight into England and English medicine of the early 19th century.

JOHN C. KRANTZ, JR.

THE FIGHT AGAINST TUBERCULOSIS. *An Autobiography.*

By Francis Marion Pottenger. Henry Schuman, New York. $4.00. xii + 276 pp. + 2 pl. 1952.

Most of what is now known about the cause, nature, and cure of tuberculosis has been learned over the past 80 years. Spanning the same 80 years, the life of Francis Marion Pottenger exemplifies, probably more than that of any other American physician, the persistent questioning, the meticulous observation, and the scientific sagacity which have characterized the struggle against one of mankind's most ancient and relentless afflictions.

In thoroughly entertaining fashion, the author has presented an intimate yet modest account of his life, from its lowly beginning on an Ohio farm to its present place of eminence as a world authority on tuberculosis. It is a life that has been endowed with a wealth of scientific curiosity, graced with a full measure of humility and understanding, and dedicated wholly to the service of the human race. Something of the stature of the man is revealed when his accomplishments are measured against the background of handicaps and difficulties under which he worked. For example, a visual defect prevented him from ever reading for more than a few minutes at a time during his entire life—a handicap which Pottenger admits served to strengthen his ability to concentrate and to retain what he had heard, and which probably augmented his keen diagnostic ability through "light touch palpation." The despair engendered by the death of his wife from tuberculosis only four years after their marriage was the primary stimulus to his acceptance of the challenge of tuberculosis as a lifetime specialty at a time when knowledge of the disease was so meager that the prognosis in most cases was considered hopeless.

The tremendous strides in the control of tuberculosis since the turn of the century are clearly summarized in the following words: "Had the 1900 death rate [from tuberculosis] in the United States prevailed in 1951, instead of some 30,000 deaths, there would have been in the neighborhood of 300,000, a saving of more than a quarter of a million people a year." The author may well be proud of having had a part in this colossal achievement. An appendix provides a bibliography of publications by the author.

B. AUBREY SCHNEIDER

DREAM AND REALITY. *An Essay in Autobiography. By Nicolas Berdyaev. The Macmillan Company, New York.* $4.50. xvi + 332 pp. 1951.

This is an unusual autobiography because it is devoted rather exclusively to the author's attempt to describe the development of his philosophy, and only touches on the actual conditions of his life in an incidental way. Berdyaev was an important Russian philosopher born under the Czarist regime. He was a member of the revolutionary movement against the Czar, was banished to Siberia, finally released, and allowed to return to his native part of Russia. He saw World War I and the overthrow of the Czarist regime, exulted in the Revolution and the new freedom it promised for the peoples of Russia, experienced a sharp disappointment in the break with the Russian intellectual heritage which the evermore insistent and restraining Marxism imposed on the intellectual life. An interested Marxist himself for a time, he deviated sufficiently to get himself exiled again, this time to leave the country permanently. He went to Berlin where he stayed a couple of years, went on to Paris where he lived through World War II, and died in 1948.

The watch-word of his philosophy and of his whole life was the freedom of the individual. Always violently opposed to any kind of social restraint upon the freedom of the individual, yet he constantly sought in social institutions of the most diverse sorts opportunities for the potent expression of individual freedom in company with others whom he thought believed in the same thing. He was constantly suffering disappointment. As already said, he was a revolutionary in the Czarist days, a Marxist in the early days of the Revolution. He later joined various political-philosophical groups, took a fling at Orthodoxy, then at Existentialism, and with all these groups he soon found himself out of sympathy because the other practitioners within the group did not live up to his unyielding need for personal freedom. He states that he was most at home in a philosophical group described as "mystical anarchists," but even with this group he did not last long. In short, he turned out to be sui generis. He knew everybody of importance in the philosophical, literary, and even political fields. He apparently made it his business to know everyone and find out what they stood for. His comments on important contemporary figures are worth noting. He felt himself completely out of touch with the landed aristocracy into which he was born; equally so with the unthinking of all classes, with the self-seekers of all classes, particularly with the émigrés in Paris, who longed only for the return of the good old days. Yet he is proud of the fact that he did not beat a path to the Soviet Embassy after World War II. He evidently remained somewhat aloof in the later years, and let those interested in him come to him. The book fails to give any clues in his early development to the reasons for his search for personal freedom. To psychologists, this is a notable missing link, although there is ample documentation of the bias in his actions.

The most thought-provoking part of the book concerns his religious views. This material is portended already in the Preface, where he states: "In the trials which I have undergone, I have come to believe in a higher power which has guided me and probably saved me from my own undoing." Also: "I am not one of those who look toward the past: I look toward the future. The past is significant to me inasmuch as it is pregnant with the future. . . . I have sought for the truth but my life has not been ruled by wisdom and reasonableness. I was always more aware of its irrational and unpredictable nature." He quotes Proust as expressing "the underlying experience of my whole life," in this fashion: "J'avais trop expérimenté l'impossibilité d'atteindre dans la réalité ce qui était au fond de moi-meme."

Though he was a firm believer in God, it was not the God of any of the traditional doctrines. "God is spirit and he acts within the order of freedom and not of objectified necessity. His activity cannot be understood in naturalistic terms. He is not present in external things and happenings, to which we attach divine names and in which we perceive a divine purpose. . . . God has no power: he has less power than a policeman. Power is a social and not a religious phenomenon. . . . If God exists, man is a spiritually independent being; and his relation to God is to be defined as freedom. . . . Sin may be understood as a loss of freedom or the trial of freedom rather than disobedience. This is how I have always experienced man's sin and alienation from God. . . . When I became conscious of myself as a Christian, I came to confess a religion of God-manhood: that is to say, in becoming a believer in God, I did not cease to believe in man and man's dignity and creative freedom. I became a Christian because I was seeking for a deeper and truer foundation for belief in man. . . . Christianity is mythological through and through as indeed all religion is and this is the only way leading to the realities underlying the Christian revelation. Christ, the God-man, is not susceptible of rational explanation, but we can give an account of the nature of his person in mythological terms. . . . Man is not subsumed in God, but is made divine, and his humanity endures in eternal life.

"Historical Orthodoxy and all exclusive claims to Orthodoxy struck me as smelling strongly of heresy, i.e., of sectarianism, and as devoid of the spirit of universality. I am no heretic and no sectarian, but a believing, free thinker. As a free thinker I cannot submit to or admit any tutelage or censorship of my thought; but my thought is deeply rooted in an initial act of faith. . . . The world cannot be self-sufficient. . . . There is hidden in some still greater depth a mysterious, transcendent meaning. This meaning is God. Men have not been able to find a loftier name, although they have abused it to the extent of making it almost unutterable.

"The most monstrous religious nightmare is that of an evil God whom men, blinded by their slavishness, regard as good. But there is another religious experience, which knows of the inscrutable divine-human mystery of God expecting from man a daring, creative response to his calling. . . . The summit of daring is reached in the awareness that on man depends not human life alone but divine life as well."

Berdyaev has some good words to say about music. "Music has acquired a very unusual and prominent place in modern civilization. . . . This prominence is not an unmixed blessing. It makes it possible for the European bourgeois to pass quickly, without any effort and unawares, for the price of some twenty francs, into the Kingdom of Heaven, and then to return with the same speed to the world of his petty, mean and unsightly affairs. . . . Music can be experienced as a way of liberation from triviality. . . ."

He is quite aware of the contradictions within himself, namely, his intense, burning need to feel free, and of his strong tendency to form stable habits. He justifies

the latter as the most economical way to get through an arduous, everyday existence with a minimum of effort. He summarizes his life as follows: "I am no master of the art of living, or in composing the differences and conflicts of which I am conscious in myself. My life has been anything but a work of art. Neither was I ever able to play with it. I have held to life with no support save a bare search for a truth wholly and utterly unlike the world, and with no other passion save the passion for freedom which dissolves the congealed and petrified modes of life and consciousness."

It is an extraordinary experience to read this book—the account of one man's effort to attain an ultimate philosophy of life. Berdyaev throughout is aware of him own impulsiveness, his apparent inconsistencies, his lack of logical orderliness, his vacillations in practical matters; but he never vacillated in his search for the ultimate, whatever the winding pathway he took to its realization. While he was aware of modern psychological theories, these seem to have played little role in the final formulation of his philosophy. He not only sought the truth; he lived it even to the point of suffering martyrdom on numerous occasions. He was honored in his late years by a doctorate from the University of Cambridge, which pleased him, and which he felt he did not deserve. The book should be of considerable interest to all psychologists and psychiatrists, who themselves are free of that heresy which he condemned in Orthodoxy, namely, sectarianism, and to all Westerners, who are curious about but have little or no background in Russian philosophy. Throughout his life, even in his exile, he prides himself on his *Russianism*. He saw in modern Russian life a tragic perversion of the essence of the true Russian spirit—a search for universality.

Considering the very stimulating character of this book and the excellent translation, it is with regret that I call attention to what is either a translation or editing error, and which occurs time and time again, much to the reader's annoyance, namely, the use of inappropriate prepositions, which betray the work as a translator's effort. It is regrettable that such a very valuable document could not have been rendered in impeccable English.

WENDELL MUNCIE

THE YOUNG NATURALIST

WHAT'S INSIDE OF PLANTS?

By Herbert S. Zim; illustrated by Herschel Wartik. William Morrow & Company, New York. $1.75. 32 pp.; ill. 1952.

How many children would spontaneously ask, or wonder, what's inside a plant? To me this question, like "What are little boys made of?" seems to be imposed on the child: and the answers given, though factual enough by contrast with the traditional "Frogs and snails and puppy-dogs' tails," will not necessarily make much more sense within the context of a child's experience.

A child may well be prompted by curiosity to ask "What's inside of *me*?", but his curiosity about plants is surely more likely to take the form: "How do they grow?" It would be possible in answering this question to embrace the information which Zim has included in this book and in addition to mention processes (respiration, transpiration) which he has here ignored.

As to details, the illustrations are inelegant and in one case at least (the brilliant green of the leaf epidermis, which suggests that its cells might be packed with chlorophyll) likely to be misleading. Incidentally, inasmuch as such terms as stamen, pistil, and ovules are given, why cannot we have an equally important one—chlorophyll? Better that our children associate it with the green plant than with the toothpaste tube!

EILEEN S. GERSH

WHAT'S INSIDE OF ME?

By Herbert S. Zim; illustrated by Herschel Wartik. William Morrow & Company, New York. $1.75. 32 pp.; ill. 1952.

A book on this topic seems to be so necessary that one hesitates to condemn any reasonable solution. But this one does not appear to provide it. In all fairness, it must be stated that a test-child of 10 pronounced it fairly interesting, but elementary. Children who are capable of demanding the symphonies of Shostakovich or Tchaikowsky should at least be given the names of their own parts: esophagus, cerebellum, coronaries; but here they are protected from these amusing and euphonious words. At the same time they are given diagrams like "path of the blood" which would baffle a heart specialist. The pictures for reflex action and feeling pain have their captions transposed, but would be confusing in any case. I must confess that the illustrations as a whole leave me unenthusiastic. They have a pervading flatness, and the picture of the skeleton is positively ghostly. Surely too, the picture of a split open skull is a little abrupt in effect—would it not be better to have the child imagine that his skull is transparent? Again on the debit side, even a small child can "feel a muscle," but the book's picture of a contracted muscle scarcely suggests a bulge on the outside—the muscle magazines do a better job! A thoughtful child might well suppose that there was a special reason for avoiding elimination and sex. I consider that this volume is an unsatisfactory answer to a real challenge and suggest as an auxiliary measure that an old edition of Gray's *Anatomy* be left on a bottom shelf.

H. R. CATCHPOLE

BOB WHITE.

By R. W. Eschmeyer. Fisherman Press, Oxford, Ohio. 50 cents. ii + 50 pp.; ill. 1952.

The story of Bob White, the quail, maintains the high standards set by earlier books in this series. Good for children 6 years old and up.

EILEEN S. GERSH

FOREST ANIMALS AND HOW TO DRAW THEM.

By Amy Hogeboom. Vanguard Press, New York. $1.75. 39 pp.; ill. 1950.

This is a child's book, which by means of progressive steps explains and simplifies the procedures for drawing animal portraits. Nine animals of varying sizes and shapes are used to illustrate the points made, and in each case a good photograph of the animal to be drawn accompanies the brief text. It is a well-done and intriguing book.

C. P. SWANSON

THE STORY OF LOUIS PASTEUR.

By Alida Sims Malkus. Grosset & Dunlap, New York. $1.50. ix + 179 pp.; ill. 1952.

The life of Pasteur, scientist and humanitarian, should be an inspiration to anyone, regardless of age. The present abbreviated version, with its necessary omissions and its scaling down to the 8- to 10-year-old reader, makes retention of that inspirational quality difficult, but the author appears to have surmounted these obstacles and to have done a creditable job, if the reaction of my own 10-year-old son is any criterion. The black-and-white drawings aid in maintaining interest and in carrying the text.

C. P. SWANSON

SCIENCE FOR A BETTER WORLD.

By Morris Meister, Ralph Keirstead, and Lois M. Shoemaker. Charles Scribner's Sons: New York, Chicago, Atlanta, San Francisco, and Dallas. $3.20. vi + 778 pp. + 12 pl.; text ill. 1952.

This highly readable ninth-grade textbook contains 10 units, covering the major fields usually covered. Two wise changes in the customary arrangement seem especially commendable: (1) The discussion of "astronomy" closes the book, rather than opens it; and (2) The discussion of "scientific methods" does not appear at the beginning but on p. 227. By that time, students should have had experience enough to benefit by a discussion of "scientific methods." Certainly no one learns to use these "methods" by being told about them. Practice in their use alone leads to skill. Then and then only is one ready for a discussion of them.

The illustrations are well chosen and should be useful in the classroom, although some might have been improved by better reproduction. As usual, there are some inaccuracies, which will undoubtedly be discovered and eliminated in new printings. Students should enjoy using this textbook.

ELLA THEA SMITH

ECOLOGY AND NATURAL HISTORY

PLANTS, MAN AND LIFE.

By Edgar Anderson. Little, Brown & Company, Boston. $4.00. x + 245 pp. 1952.

Edgar Anderson is a many-faceted individual, and his interests and talents lie in as many directions. His classical work in the cytotaxonomy of *Iris* and *Tradescantia*, his elaboration of these and other studies into his thesis of introgressive hybridization as a potent factor in plant evolution, and his more recent excursions into ethnobotany are indicative of a restless and fertile imagination coupled with a vigorous intellect and vast energy. He generates ideas as an apple tree sheds fruit in a high autumn wind; as with the fruit, some are good, others not so good. He has never been unwilling to speculate, and although some of his ideas have not gained acceptance, Anderson could never be accused of being dull, uninteresting, or unprovocative. The present volume is a faithful reflection of its author.

Plants, Man and Life is the story of its author's quest for answers to the interrelations of plants and man, in particular as it relates to those plants which man, consciously or unconsciously, has carried with him in his wanderings. In Anderson's opinion, man is an evolutionary factor to be reckoned with if we are to understand the changing floras of the world, and he gives proof not only of how crop plants, but also those plants which for one reason or another are associated with the human habitat have been altered through the centuries to such an extent that their original homes are no longer known and their morphology and requirements make it difficult to determine their original progenitors. His chapter on the important crop plants amply demonstrates the diversity of origin of those species upon which we now depend for food and fiber. It is with this detective story that the book is largely concerned, and it is with this aspect of botany that Anderson takes up his quarrel with the classical taxonomist and the not so classical geneticist. It is his contention that our commonest weeds and botanical immigrants can provide many of the answers to problems of evolution, yet because of their rather considerable morphological diversity and economic unimportance (excepting of course the crop plants) they are the bane of the taxonomist and the scorn of the geneti-

cist. Both of these specialists are orderly to an extreme, and like their specimens to fit into well-defined pigeonholes—to do this with the ubiquitous weeds is difficult if not impossible—but Anderson feels that both have passed up a good thing. These weeds can tell a fascinating story to one who is willing to strike beyond the confines of his science, and study them from the historical, economic, geographical, and anthropological as well as from the strictly botanical point of view.

The point is illustrated by the studies that have been carried on in the wheats, one of our most important crops. The combined efforts of many men of diverse interests and nationalities have shown that the macaroni and bread wheats have in them the genes of two or more wild species of grasses, and a reasonable hypothesis has been advanced as to how this happened in the past. The cytologists, geneticists, and taxonomists have combined forces to untangle this mystery. Yet, as Anderson points out, additional clues can be obtained from a study of the primitive agricultural methods now employed by the peoples of India and Asia Minor, for in these areas the farming practices are such as to favor the admixture of genes from the wild species into those which man purposely maintains. Presumably these practices, also found among the Indians of Central and South America, are more nearly like those of our early ancestors than are the more efficient, one-crop-per-field methods of the American and European farmer. Crop mixtures are the rule, not the exception, in the Near and Far East.

The coming into its own of the tomato provides another example of the manner by which some crop plants have been developed. Related to weedy, small-berried plants of South America, the tomato traveled to Europe as a curiosity, was developed by the Italians into an important item in the everyday diet, and was then brought back to America by Italian immigrants. Today it is, of course, a major food plant on the American table, but this has all occurred during the lifetime of the author. Why did the Italians so quickly pick up and develop the tomato when other peoples did not? It will take a bit more detective work to find this out, but one will have to know more than just botany to do it.

As a whole the book is an excellent combination of fact and speculation, with the latter clearly identified for those who do not know the field well enough to judge critically. The fact that it is written in a semi-popular fashion in no way detracts from its usefulness; rather, it makes a highly intriguing area of research available to an audience far wider than that represented by the ethnobotanists. Anderson knows how to employ the well-turned phrase, and to make use of illuminating analogies. The chapter How to Measure an Avocado contains the heart of his methods of detection, while in the chapter Budgets vs. Scholarship he makes his plea for the breakdown of the barriers that for budgetary reasons exist between the usual university departments, and that serve to keep apart men of diverse interests and hence to prevent the cooperative research which must of necessity be brought to bear on these problems, if we are ever to understand the origins of agriculture and of the plants upon which we depend. There are, most certainly, botanists of one specialty or another who will feel that Anderson, while having a wonderful time doing what he does, has let his imagination run away with him on this hypothesis or that, but if this discursive approach, with its free speculation, stimulates others in this area of study or provides a point of departure for further research, one can complain with much less justification. Certainly *Plants, Man and Life* is an unusual and highly interesting book, which is reason enough for being.

C. P. SWANSON

FOOD OR FAMINE: *The Challenge of Erosion.* *By Ward Shepard. The Macmillan Company, New York.* $3.00. xii + 225 pp. + 16 pl.; text ill. 1947.

An extravagantly over-written and wordy plea for and defense of soil conservation. As the author says, this book, tentative and incomplete, deals with the broad aspects of the social design and engineering that must be applied to one of the greatest of man's problems: reconciling civilization with nature. He deals with the broad outlines of a program which he hopes will conserve and develop the best in the soils, land, forests, and water resources. He emphasizes that conservation is a basic international problem; that nature is an equilibrium of dynamic and living forces; and that conservation requires not only revolutionary changes in certain technical methods of agriculture, but that it requires also revolutionary changes in the relation of governments to agriculture, in the methods of promoting truly scientific agriculture, and in methods of administration and finance. He reminds the reader that man has perfected incomparable tools of science in all realms of life, but social invention in using those tools for human welfare is disorganized and laggard. Only by social design on a grand scale can man reap the fruits of his scientific genius. In a more considered style, a strong plea is made that soil conservation districts be made more inclusive to enable them to deal with various problems of forest ownership, forest taxation, and other difficult economic problems. The questions of integral watershed development are considered, and a possible solution of states' rights in extensive river valley authorities is suggested. It is implied that all important soil conservation measures were invented by the Soil Conservation Service. If the author had had field experience in peasant agriculture in some Asiatic countries, or if only he had

read King's *Farmers of Forty Centuries*, he might have acquired a better perspective. He would hardly have rated the contour furrow a more important conservation invention than the diked and levelled padi (lowland rice field). On the other hand, he does admit that in the tropics many soils present unsolved and possibly insoluble technical problems. If he had had Asiatic experience with peasants, it seems very unlikely that he would still contend that the farm management plan is the key to and the tool for the scientific reorganization of world agriculture, or that the world deterioration of soil resources cannot be checked until governments provide expert services in organized land management districts, on a scale of intensity to bring all land under scientific management by the method of the complete management plan. In a free world, in Asia at least, such an ideal cannot be expected for centuries.

ROBERT L. PENDLETON

NORTH OF THE CIRCLE.

By Frank Illingworth. Philosophical Library, New York. $4.75. vi + 254 pp. + 32 pl. 1952.

The author has done himself a disservice in presenting to the public a book so carelessly written as this one. Barely a page exists without some error in spelling or substance. It is difficult to imagine any serious proofreading of this journalistic bit. Some items will be shocking to almost every informed reader, and depressing to arctic enthusiasts. As examples; "Grealy" (who the author reports as having died in the Arctic) in place of Greely; "Richard Peary" in place of Robert Peary; "Amundson" in place of Amundsen; "Wagener" in place of Wegener; "Isaacson" for Isachsen. Name places are even more carelessly handled. As for substance, on one page, the author defines the southern limit of the arctic by the tree-line (correctly), but later writes that the arctic is the most heavily wooded part of the world excepting the tropical forest. Remarks like "Life in the Arctic & Sub-Arctic offers no insuperable problem to women of Nordic stock" (p. 33), and "They (the Russians) set about their task with the meticulous attention to detail associated with the Anglo-Saxon race ..." (p. 142); and, that the 53rd isotherm "coincides with the tree-line, and provides [in Canada] a cultural line between the territory of the white man and that of the arctic's natural inhabitants the Eskimo and the Northern Indian ..." indicate the author's weakness in the anthropology of the Arctic. In physiology and geography, Illingworth is even weaker. The photographs are good, but some of the captions misleading. The final shock comes on the very last page, called Acknowledgments. Speaking of acknowledgments to the works of Vilhjalmur Stefansson (incidentally two very important ones, *The Friendly Arctic* and the *Arctic Manual*, were not used), Illingworth confirms his carelessness: *My Life with the Eskimos* should read *My Life with the Eskimo;* and what Illingworth calls *Northward Across Empires* should be *The Northward Course of Empire.* The Arctic Institute of North America publishes *Arctic;* but the *Arctic Circular*, which is an excellent mimeographed monthly, is put out by the Arctic Circle (Ottawa). It is indeed depressing to see another poor book written on the Arctic. Illingworth has great enthusiasm for the Arctic, and there are occasional indications in the quality of some passages, that with serious study and proper care a good book could have been written by him. This was not it.

M. C. SHELESNYAK

THE NATURAL VEGETATION OF THE WINDWARD AND LEEWARD ISLANDS.

By J. S. Beard. Oxford University Press, New York and London. $5.00 (paper). 192 pp. + 16 pl.; text ill. 1949.

This monograph on the vegetation of the British Lesser Antilles forms a companion volume to Beard's *The Natural Vegetation of Trinidad* (1946). The French islands of Martinique and Guadeloupe are also included, and reference for comparative purposes is made to the British and American Virgin Islands, Puerto Rico, Trinidad, Tobago, and the small oceanic island of Mauritius in the Indian Ocean. Treatment of the subject is in five parts: factors of the environment, plant geography, classification of plant communities, description of communities, and comparative studies. Phytogeographic theories as to the origin of the Lesser Antillean flora are based on an analysis of the distribution of 243 tree species. The major portion of the monograph is concerned with the classification and detailed description of the plant communities on each of the islands in the archipelago. The book is profusely illustrated with vegetation maps, profile line drawings, and halftones—all of excellent quality.

SCOTT S. PAULEY

THE TROPICAL RAIN FOREST. *An Ecological Study. By P. W. Richards. Cambridge University Press, New York.* $12.50. xviii + 450 pp. + 15 pls., 3 folded charts; text ill. 1952.

With increasing interest currently directed to the tropical regions of the world by foresters and agriculturists, this book has a unique timeliness. Its subject matter encompasses all that is known of the ecology of the tropical rain forest, the evergreen forest of moist tropical lowlands. This is no mean undertaking when

one realizes that such forests include about half of the world's forest area. Principal reference is made to the 3 main regions of tropical rain forest: Malaysia, South America, and Africa, in all of which the author has had first-hand experience. The discussion consists of 6 principal parts: Structure and Physiognomy; The Environment; Floristic Composition of Climax Communities; Primary Successions; Tropical Rain Forest under Limiting Conditions; and Man and the Tropical Rain Forest. Full reference is made to the recent voluminous and scattered literature, as well as to much unpublished data available through various tropical forestry departments and other agencies. The book is thoroughly and well illustrated and, in general, is so well organized and written that it will provide enjoyable as well as instructive reading for any biologist, regardless of his special interests.

SCOTT S. PAULEY

NATURAL COMMUNITIES.

By Lee R. Dice. The University of Michigan Press, Ann Arbor. $5.50. x + 547 pp.; ill. 1952.

This book exemplifies the essence of ecology by presenting data about animals and plants from a synthetic viewpoint—that of the community. At all times the reader is kept aware of the integrative factors in a group of animals and plants that live together and form the community. The impossibility of separating plant communities from animal communities is stressed. The book is written so that a mature undergraduate or non-ecologist can readily grasp the essential ideas. Such basic points as the relation to other aspects of biology are indicated. Notable is the detailed description of the use of some mathematical methods for analyzing data.

The several chapters deal with different parts of the community without loss of unity. Quite properly measurements are discussed at some length at the start. Then the physical factors are described. The subsequent chapters are concerned with populations, behavior, interspecific relations, succession, and other topics that pertain to the community. At times one wonders if the relation to a community is not rather tenuous.

The title *Natural Communities* makes one ask what "unnatural" communities might be. Apparently "unnatural" communities are those modified by man (p. 10). But if man has been in North America for 25,000 (or even 300,000) years, where can any natural community be found? Indeed all the data presented in the book refer to communities modified in some way by man. The artificial distinction between "human" communities and "animal" communities is a positive hindrance to the development of general laws of human sociology and geography.

The book is superbly printed and adequately illustrated with drawings. It contains a fine list of references, although many recent articles are not mentioned. The book will be found useful both as a reference work and as a textbook for mature students.

DAVID E. DAVIS

THE OCEAN RIVER.

By Henry Chapin and F. G. Walton Smith. Charles Scribner's Sons, New York. $3.50. x + 325 pp. + 4 pls.; text ill. 1952.

Books about the sea are coming off the presses at a steady rate these days in the wake of Miss Carson's success. Perhaps this is simply in response to man's perennial interest in the sea, or perhaps we are in the midst of a high tide in the cycle of writing and reading about the sea and its life (like our Victorian forebears a hundred years ago). Whatever the explanation, here is still another book about the sea—the Atlantic Ocean in particular. This one is the result of a collaboration between a "historian and anthropologist" and "one of the world's foremost oceanographers and marine biologists." A combination like this promises much to the reader, but unfortunately something went wrong, and the result is an undistinguished addition to the several hundred books that have been written about the sea.

For one thing, there are too many different themes in this book: a lot of warmed-over history about Columbus, cod, and the slave trade, still another chapter on Atlantis, and a philosophical apostrophe to the Atlantic world. These have been done dozens of times before, and the authors' regret that they could not go into "scientific aspects" in more detail seems a bit perfunctory. The real trouble, however, is the vagueness of this "Ocean River," by which is meant sometimes the Gulf Stream, sometimes the whole North Atlantic current system, and at other times (apparently) the ancient Oceanus encircling the world. It is seldom quite plain which meaning the authors have in mind in a given place. Many of the sentences, for that matter, are not plain; the authors have an unhappy tendency to fall into grammatical booby traps. The frequent lack of harmony between subject and predicate (to say nothing of the hybrid metaphors) suggests that this book was "dictated but not read." The following is a typical example of the style: "The ships which have made history in sailing the seven seas have been born of a commercial and technological growth which has had its outpost in Sweden and Texas, Cape Cod and Tyneside, and its center at the center of the Atlantic whirlpool" (p. 9). Or another: "Scientists who devote their attention to the great sea fisheries are concerned not only with problems of migration, of food and growth, of the complicated effects of drifts and current of hot and cold, of salt and fresh." (p. 198).

Of the science itself, what there is of it is acceptable for a popular book, although such things as the exposition of MacCallum's hypothesis about blood and sea water and the discussion of the origin of crustacea from trilobites might have been more critically presented, and there are the usual little mistakes that we have come to expect in books such as this. It must have been the senior author who wrote (or said), "the sea is biologically independent of the land" (p. 8), and the junior author who said precisely the opposite (p. 186). The bibliography, with at least 7 mistakes on the first 2 pages, must have been compiled by the secretary.

JOEL W. HEDGPETH

LIMNOLOGY. *Second Edition. McGraw-Hill Publications in the Zoological Sciences.*

By Paul S. Welch. McGraw-Hill Book Company, New York, Toronto, and London. $8.00. xii + 538 pp.; ill. 1952.

It is always pleasant to look through a new edition of an old standard work and find it to be an improvement on the original edition. The first edition of *Limnology*, published in 1935, filled a much needed gap in the literature. At that time there was no comprehensive textbook in freshwater biology by an American author, and the book became a standard reference work in the literature of ecology. This new edition is both substantially larger and as up to date as can be expected in a rapidly advancing field of research. 67 pages have been added, but relatively few more figures. It is in fact surprising that the book is not much larger, in view of the new material. This is probably the result of limitations of space, as noted in the new Preface. On the practical side, this is compensated for by the same author's *Limnological Methods*, 1948, since the two books together give a much broader coverage of limnology.

The present edition contains the same number of chapters as before, and organized in the same general way. Part I (Preliminary Considerations) contains 3 chapters that deal with introductory remarks, inland waters in general, and the origin and diversity of lakes. Part II (Nature of Inland-Water Environments) contains 2 chapters covering the physical and chemical conditions, together with related phenomena of the inland-water environment. Part III (Biological Relations) is the largest section in both editions (9 chapters) and has received the major share of the added space. These 9 chapters cover in sequence the influence of physical conditions, that of chemical conditions, the inland-water organisms in general, plankton, bacteria as well as other fungi and the nonplanktonic algae, larger aquatic plants, nekton, benthos, and biological productivity. The chapters on plankton and on biological productivity seem greatly improved, although the discussion of biological productivity may be thought too conservative by some hydrobiologists. Part IV (Some Special Types of Lentic Environments) contains 2 chapters, one on ponds and one on bog lakes. A third chapter to discuss the limnological aspect of tree holes, both temperate and tropical, would have been appreciated. Part V (Lotic Environments) concludes the text with a single chapter on flowing waters in general. There follows a bibliography of 68 pages, completely redone, substantially enlarged, and divided into more or less independent sections that in a broad sense support the major subjects covered by the chapters. This new bibliography should be specially useful for the numerous references it contains to recent research, much of which is alluded to or cited in the text but is not fully discussed there. The book concludes with a general index.

ORLANDO PARK

LIMNOLOGICAL METHODS.

By Paul S. Welch. The Blakiston Company, Philadelphia and Toronto. $7.00. xviii + 381 pp.; ill. 1948.

The stated purpose of this book is to provide those basic methods that are necessary for (1) an entry into the study of limnology, (2) limnological surveys of streams and lakes, and (3) the collection of fundamental information upon which specialized research in limnology depends. No attempt is made to list and describe every different method in use, although a great many, and the more important methods are fully described and documented. Rather, the volume is a highly selective compendium. The author is an authority in the field of study, and the three objectives set forth have been achieved.

An introductory chapter deals with such practical matters as the choice of a particular method and its application, the correction and calibration of equipment, marking of equipment, the reading of instruments and their care, and the recording of data. Following this are 4 sections, dealing with (1) hydrographic mapping and morphometry, (2) physical methods, (3) chemical methods, and (4) biological methods. The mapping of lakes and streams is stressed in the first section since, although this is of basic importance in limnology, many limnologists lack training in such work. Selected references are gathered after a group of cognate chapters, or after a single chapter. There is a large appendix full of useful information. This includes 13 tables of information useful to work in limnology, accessory equipment, sources of apparatus and supplies (cited from a special publication of the Limnological Society of America), and a bibliography for the identification of plankton. The book closes with a good general index.

ORLANDO PARK

THE ANIMAL LIFE OF TEMPORARY AND PERMANENT PONDS IN SOUTHERN MICHIGAN. *Misc. Pub. Mus. Zool., Univ. Mich., No. 71.*

By Roman Kenk. University of Michigan Press, Ann Arbor. $1.00 (paper). 66 pp. + 3 pl.; text ill. 1949.

This is a report of a field investigation of 4 ponds in the vicinity of Ann Arbor, Michigan, between October, 1940, and June, 1941. Since temporary ponds of the area are thought of as a transient evolutionary stage that follows permanent ponds and precedes the disappearance of bodies of standing water, two of the ponds selected were temporary, holding water at some time of the year, and two were permanent, holding water throughout the year. One temporary pond was at the edge of a second-growth hardwood forest; another temporary pond was situated in open grassland; one of the permanent ponds was an impounded portion of the Huron River, with consequent penetration of elements of the river fauna.

The geography and vegetation of each pond is discussed briefly. This is followed by a 10-page table in which the faunas of all 4 ponds are contrasted, in terms of rare, common, or abundant for spring and winter seasons. Collection of animals was attempted each fortnight during the period when the temporary ponds held water. Strictly quantitative methods of collecting were not employed. Only macroscopic groups were studied, and included coelenterates, turbellarians, oligochaetes, leeches, crustaceans, arachnids, insects, snails, clams, bryozoans, fishes, amphibians, and reptiles. Microscopic groups (protozoans, rotifers, gastrotrichs, and nematodes) were not studied. These collections were accompanied by determination of the hydrogen-ion concentration colorimetrically, alkalinity of the pond waters by the methyl-orange method, and dissolved oxygen by the Rideal Steward modification of the Winkler method.

Nearly 300 species of macroscopic organisms were identified by numerous taxonomists in the course of the work. The largest section of the paper is a 23-page account entitled Ecology of Pond Animals, in which the several taxonomic groups are taken up en suite, and the several species discussed as between the ponds mentioned. The report closes with a bibliography and some good halftones of the ponds studied.

ORLANDO PARK

DIE WASSERSPINNE. *Die Neue Brehm-Bucherei, No. 44.*

By Wolfgang Crome. Akademische Verlagsgesellschaft Geest & Portig K-G., Leipzig. DM. 1.50 (paper). 47 pp. 1951.

This semipopular booklet is one of a series designed to acquaint the naturalist with native German plants and animals, and describes the European water spider *Argyroneta aquatica* Clerck. It tells in detail and with many illustrations the life history and habits of this unusual spider.

HERBERT W. LEVI

ISLAND LIFE: A STUDY OF THE LAND VERTEBRATES OF THE ISLANDS OF EASTERN LAKE MICHIGAN. *Cranbrook Institute of Science, Bulletin Number 27.*

By Robert T. Hatt, Josselyn Van Tyne, Laurence C. Stuart, Clifford H. Pope, and Arnold B. Grobman. Cranbrook Institute of Science, Bloomfield Hills, Michigan. $4.00. xii + 179 pp. + 23 pl.; text ill. 1948.

Investigation of insular plants and animals has made substantial contributions to biology, especially in the field of organic evolution, and including such important studies as those of Charles Darwin on coral reefs and the Galapagos Islands, and of Alfred R. Wallace on the Malay Archipelago. The volume under review is a comprehensive study of the amphibians, reptiles, birds, and mammals that inhabit 18 islands in extreme northeastern Lake Michigan. Between 1937 and 1944 a series of trips was made in this region, primarily by the Cranbrook Institute and the University of Michigan. These land vertebrates were observed in the field, collected, and identified. The data are assembled and integrated with the literature in 9 chapters. First the the islands are discussed with respect to their geological history, cultural history, and geography. The next 3 chapters comprise about 40 per cent of the text and deal with the amphibians and reptiles, birds, and mammals, respectively. These are largely annotated checklists chiefly having to do with local distribution, species ecology, and behavior. They should be of particular interest to specialists in these groups.

The last chapter is of more interest to biologists in general, as it is a thoughtful integration of the previous 8 chapters in terms of factors of distribution. An appendix lists the scientific names of the animals studied; and there is a bibliography and an index.

ORLANDO PARK

OUR AMAZING BIRDS. *The Little-Known Facts About Their Private Lives.*

By Robert S. Lemmon. The American Garden Guild and Doubleday & Company, New York. $3.95. 239 pp.; ill. 1952.

Lemmon has selected about 100 species of North American birds and written short accounts of their appearance and behavior. As the title suggests, he has concentrated on the unusual—birds outstanding for beauty, for size, for speed of flight, or in other ways.

The text is in no way sensational, however, and provides a reasonably comprehensive, popular introduction to American birds. The book is lavishly illustrated with paintings, reproduced in black and white, by Don R. Eckelberry, one of the most talented and vigorous of the younger generation of nature artists.

D. AMADON

AMERICAN WATERFOWL. *Hunting Ducks and Geese. By Bert Claflin. Alfred A. Knopf, New York.* $5.00. xviii + 285 pp. + 6 pl. 1952.

The subtitle sufficiently indicates the contents of this volume. It contains little natural history, and that little is not very accurate.

D. AMADON

WILD WINGS.

By Frank S. Stuart. McGraw-Hill Book Company, New York, Toronto, and London. $3.50. xii + 222 pp. 1952.

A book of this sort could probably be best reviewed from two distinct viewpoints: literary and scientific. As a literary creation *Wild Wings* appears to be first rate. The story describes the annual cycle of activity in the life of a flock of wild ducks from the time it leaves for its nesting grounds in the north until its return the following fall. The dangers encountered and travails undergone from predators, fires, storms, poachers, and others, during migration and nesting, are excitingly recounted. Each chapter ends in suspense that forces the reader to continue. The protagonists form a triangle, being concerned with the rivalry between a pair of pintails and an intruding, persistent, albino mallard drake.

From the ornithologists' point of view, there is no doubt that the author knows ducks. The cold, calculating, stony-eyed scientist will object to the thoughts and unspoken comments attributed to the birds—but then where would the story be? With regard to orientation in migration there is confusion as to whether the birds use visual cues, physical guides, or instinct; but everyone else is also confused on the subject. Whether small birds, which migrate at night, actually spend all day sleeping and resting is debatable; it certainly is not true in all cases. Considerable prescience is attributed to the ducks, and much of their behavior is implied to be purposeful. Again to describe these activities in cautious scientific objectivity would render the story sterile. The reader, nevertheless, should take heed and not gain a false impression regarding the reasoning ability of these animals. In one place, an interesting maneuver on the part of the mother duck is described, where she squats low beside a duckling and flips it on her back with a flick of the wing and then proceeds to transport the young to the water. I was unaware that this was ever done by ducks. All persons interested in nature, birds, or wildfowling will enjoy this story. Fortunately no maudlin sentimentality is involved. The book is recommended for pleasurable reading.

HENRI C. SEIBERT

TEXAS RANGE GRASSES.

By Benjamin Carroll Tharp: with drawings by Clare Y. Whaley. University of Texas Press, Austin. $4.00. xiv + 125 pp. + 2 folding maps; ill. 1952.

This book presents a survey of the distribution and relative abundance of the 168 species of Texas grasses of greatest importance to the rancher from the standpoint of grazing, soil coverage, and potential biological utilization. It is the first of a series projected by the Grass Research Project of the Plant Research Institute of the University of Texas to further the conservation and improvement of range grasses, and represents more than 30 years of investigation in the field and herbarium.

The general approach is ecological, and the grasses are classified according to the 18 vegetational regions of the state. An introduction deals with Texas as a plant environment and treats briefly of the geographic extent and relief, drainage, precipitation, soils and geology, relative humidity, evaporation and winds, and temperature. Each of the vegetational regions are then discussed in some detail, and the grasses are listed according to their relative abundance.

A summary presents notes regarding the general distribution and importance of the grasses outside Texas. One appendix is concerned with the chemical composition of certain of the species; a second gives a comprehensive analytical list in tabular form of the more important species, showing their distribution and relative abundance. There is a short bibliography. 25 of the principal species are illustrated by line drawings. Five maps show the topography, average annual precipitation, vegetational regions, precipitation/evaporation figures, and soils.

ALBERT F. HILL

EVOLUTION

OUTLINE OF HISTORICAL GEOLOGY. *Second Edition. By A. K. Wells; revised with the assistance of J. F. Kirkaldy. Thomas Murby & Company, London.* 25s. xvi + 356 pp. + 2 pl.; text ill. 1948.

Although lacking the wealth of photographic illustra-

tions to be seen in such an American textbook as Moore's *Introduction to Historical Geology*, this short textbook will be especially valuable to readers who would like an elementary reference work to the historical geology of Great Britain, the classical area where modern geology was founded. The author, of King's College, University of London, prepared this work with the cultural interests of general, rather than professional, students in mind.

PATTERNS OF SURVIVAL. *An Anatomy of Life. Second Edition.*

By John Hogdon Bradley. Grune & Stratton, New York. $3.75. ix + 223 pp. 1952.

To call this book a "second edition" is to introduce to the United States the unfortunate and misleading practice of the Old World of calling every reprinting of a work an "edition," irrespective of whether the new "edition" is an exact reprint, has had only a few typographical or minor errors corrected, or has undergone an extensive and fundamental revision. This practice is to be deplored and protested. The volume in hand has been changed by not a word from the 1938 first edition, published by Macmillan. It is properly described as a "reprint," as which it is welcome enough. (For a review, see *Q.R.B.*, 14: 226. 1939).

BENTLEY GLASS

EVOLUTION IN THE GENUS DROSOPHILA.

By J. T. Patterson and W. S. Stone. The Macmillan Company, New York. $8.50. viii + 610 pp. + 1 folded map. 1952.

This book contains an extensive, well-balanced account of how evolution is believed to have occurred in *Drosophila*, written by two men who have, along with their colleagues at the University of Texas Laboratory, been among the most active contributors to this field during the past 15 years. The book has a useful 37-page bibliography, a good index, and is generously illustrated. The authors begin by indicating what they mean by a species, and like most recent workers in the field of *Drosophila* evolution, they use a "biological" species definition, that is, one based on all available criteria, with particular emphasis on reproductive isolation. The second chapter contains a concise summary of the taxonomic subdivisions of the genus and a list of all of the species sufficiently well known to be assigned to one of the 8 subgenera and the numerous species groups. Of the 613 species described for the world, approximately 43 per cent can be so assigned. Considering the wealth of illustrative material available to the authors, a few illustrations of members of the various species would have been a worthwhile and practical addition to this chapter, particularly since most biologists have seen only one species, *D. melanogaster*.

The third chapter, which covers the geographical distribution, is unfortunately marred by the fact that a number of the maps are entitled, "Distribution of the known records . . ." for the various species groups, whereas in fact these same maps show only a very restricted part of the range of some of the species considered. This will cause the careful reader no particular difficulty, as the text clears up the matter, but it could cause a great deal of trouble to anyone trying to use the figures alone as a reference.

In the fourth and fifth chapters the inter- and intraspecific chromosomal variability is outlined diagrammatically. The authors point out that there is no reason to assume polyploidy as an evolutionary force in this genus, but that duplication of parts of chromosomes is a ready source of new genes, and should permit an increase in the hereditary material available without the temporary loss of mutational flexibility that may occur in polyploids. They also indicate that departures from the basic chromosome set of five rods and a dot have usually been in the direction of a decrease in number (by fusion of chromosome arms), rather than an increase, and that most of the observed chromosomal variability within the genus has arisen independently within the various species groups. Evidence is presented to support the conclusion that in the course of evolution the original 6 chromosome elements have not always remained intact, but have exchanged parts, largely through pericentric inversions. This viewpoint is in contrast to the earlier conclusions of Sturtevant and Novitski.

In the sixth chapter, which is on Mutation, Selection and Genic Balance, the authors give a rather extensive, well-written defense of the thesis that mutation, recombination, and chromosomal rearrangements are sufficient to supply the genetic variability needed for evolution, without the need to explain the formation of species or higher categories by macromutations, as Goldschmidt has suggested. Chapters 7, 8, and 9 cover isolating mechanisms of various kinds. In the section on hybrid sterility and lethality more than 100 cases of hybridization are discussed, with a very interesting summary of the great variety of ways in which genic differences between species may lead to hybrid inviability or sterility. The authors feel that the evolutionary development of sexual (psychological) isolation between species is usually incidental, rather than the result of selection pressure within the zone of overlap, as Dobzhansky has suggested. In Chapter 10 the evolution of the *D. virilis* species group is considered in some detail. This group has received the special attention of the Texas workers, and it is largely due to their efforts that its evolutionary relationships are better understood

than those in any other comparable *Drosophila* group. In a few cases the tables in this chapter and the preceding ones on isolating mechanisms are so inadequately explained that the uninitiated reader would have to return to the original research papers to understand them. In the final chapter the data from the earlier material is summarized, the intergroup relationships are reconsidered, and a comparison is made between the taxonomic units in *Drosophila* and those in other animals and in plants. Throughout the book the authors place considerable emphasis on the ecological information available, both as a tool in classification and as a guide to the probable evolutionary mechanism. They feel, for instance, that the large number of species in the *D. repleta* group is associated with its successful invasion of a new (desert) habitat, and a subsequent explosive speciation under ecological conditions which have promoted the formation of many small, partially isolated populations.

In summary, this is a first-rate book, showing not only breadth of coverage, but depth and balance in the discussion. It may be read with profit by anyone interested in either evolution or *Drosophila*.

HARRISON D. STALKER

THE PROBLEM OF THE SPECIES HAVING A TRANS-ADRIATIC DIFFUSION, WITH PARTICULAR REGARD TO COLEOPTERA. *Memorie di Biogeographia Adriatica. Pubblicate con il Contributo del Consiglio Nazionale delle Ricerche. Vol. I.*

By E. Gridelli. Istituto di Studi Adriatici, Venezia. Lit. 3000. (paper). 299 pp. (with 11 pp. Eng. summary); ill. 1950.

The author has studied the geographic distribution of beetles occurring at both sides of the Adriatic Sea, and gives an annotated list of the 138 known species and distribution maps of 45 species. From this empirical material the author draws a number of conclusions as to the origin of the species and their history during geological times. Some species occur in the Balkans and Southern Italy but not in the intermediate land regions. Such a distribution is interpreted as due to a land connection at some earlier geological age. The author traces the geological history of the Adriatic and sets forth evidence that such land bridges have existed during parts of the Miocene and again later during the Pleistocene (Dalmato-Garganic ledge). He assumes that a migration of species occurred over this Pleistocene bridge in both directions, but that some species already existed on both sides of the Adriatic since the Miocene period. Finally, there is a study of the fauna of the Tremiti, Pianosa, and Pelagosa islands which represent fragments of the Pleistocene land bridge. The monograph forms an interesting study in a field where not a great deal is known reliably.

G. H. DIEKE

GENETICS AND CYTOLOGY

ELEMENTS DE GENETIQUE ET D'AMÉLIORATION DES PLANTES. *Tome I: Les Mécanismes de l'Hérédité Élémentaire ou Factorielle.*

By Pierre Chouard. Centre de Documentation Universitaire, Paris. 450 fr. (paper, mimeographed). iv + 115 pp.; folded charts, text ill. 1951.

It is difficult for American students, growing up surrounded by good books, well printed and produced, and not too expensive, to visualize the situation of the French- or Spanish-speaking student, for whom modern scientific books are few in number, miserably printed on poor paper, and relatively dear. The reasons for this situation are doubtless complex, including the wide market provided by America and the rest of the English-speaking world, our relatively large number of aspiring authors, and the willingness with which we cut down our forests. Whatever the reasons, the fact is that the appearance of a book on genetics and plant breeding in the French language is an event of considerable importance. This is the first of a series of three in which Chouard plans to cover the whole field. It is a modest 114-page mimeographed affair in paper covers, and costs about $1.50. The bibliography is unfortunately postponed to the second volume. In this first volume there are treated: meiosis and mitosis, simple Mendelism, linkage, relative dominance, multiple alleles, gene interaction, and sexuality in plants. The second volume is to deal with "complex heredity in its creative or evolutionary aspects," and the third with the genetic history of the principal wild and cultivated plants.

The special purpose of presenting plant genetics by itself, according to Chouard, is because too much insistence on teaching *Drosophila* genetics may give "the satisfying appearance of theoretical generality" but "risks hiding from the beginner the richness of the genetics of plants." It is true, too, that quantitative genetics began with plants (peas) and is now, after a long period of zoological dominance, again most active with plants (*Neurospora*, bacteria). One may guess, too, that students interested in agricultural and horticultural applications are very much in the author's mind.

The presentation of cell division is clear, some of Mendel's experiments are presented in numerical detail, and there are the expected diagrams of segregation and of crossing-over. The role of varying degrees of dominance and of multiple dosage is described succinctly and simply in terms of flower color. Heterosis is treated only very briefly (3 pp.) but its applications are to come in later volumes. Heterothallism and the behavior of dioecious plants are included at the end.

In general, the level of the work is about that of other regular textbooks. With the exception of a very few chemical formulae, biochemical and physiological matters are avoided. This may be justified in an introductory treatment, but it seems unfortunate in these biochemical days that some discussion of gene-enzyme

relationships, however simplified, could not have been worked in. Perhaps the next volume will remedy this.

KENNETH V. THIMANN

STRUCTURE IN RELATION TO CELLULAR FUNCTION. *Ann. N. Y. Acad. Sci., Vol. 50, Art. 8. Pp. 815–1012. By Robert Chambers (ed.) and 11 contributors.* $3.00 (paper). 1950.

This volume, the contributed papers of a symposium held in May, 1947, includes the following: The Cell as an Integrated Functional Body (Robert Chambers); Surface Properties of the Erythrocyte (M. H. Jacobs); The Ultrastructure of the Envelope of Mammalian Erythrocytes (David F. Waugh); Studies on Cell Morphology and Functions: Methods and Results (Albert Claude); The Localization and the Role of Ribonucleic Acid in the Cell (Jean Brachet); The Surface Chemical Properties of Cytoplasmic Proteins (M. J. Kopac); Salivary Gland Chromosomes (Ethel Glancy D'Angelo); Chromosomal Physiology in Relation to Nuclear Structure (William R. Duryee); Fiber Protein Structure in Chromosomes and Related Investigations on Protein Fibers (Daniel Mazia); Pitfalls in Histochemistry (George Gomori); Enzyme Systems of Isolated Cell Nuclei (Alexander L. Dounce); The Function of Cell Inclusions in the Metabolism of *Chaos chaos* (Heinz Holter); Concluding Remarks (Robert Chambers).

Rarely has a better selected and more authoritative panel been assembled to discuss cytological problems of current importance. The book would therefore have outstanding merit were it not for two most unfortunate defects. In the first place, nearly 3 years elapsed between the date of the symposium and its publication. Inasmuch as most papers given at symposia show their age quite rapidly, the present work was out of date before it appeared. This is inexcusable, in view of the fact that it has been demonstrated that it is not impossible to publish symposia within 6 months, or at most a year, from the date when the meeting was held. Secondly—and this in my estimation amounts to a scientific crime—there is no provision of any index whatsoever. By late publication the reader's need to work through the entire volume with care is minimized, and by lack of an index it is made utterly impossible to use the volume as a reference work. Scientists ought to protest this type of editorial irresponsibility in the strongest terms.

BENTLEY GLASS

STRUCTURAL ASPECTS OF CELL PHYSIOLOGY. *Symposia of the Society for Experimental Biology, Number VI. Academic Press, New York.* $7.50. vii + 357 pp. + 22 pl.; text ill. 1952.

It is of course belaboring the obvious to state that structure and function are but different facets of the same problem, that of understanding the workings of the cell as an integrated unit of living matter. The fact that the issuance of a volume on the interrelationships of morphology and cell physiology meets a demand and a need, however, is ample proof that what is obvious often requires recalling to mind. It is all too easy to forget, during the search for the solution to a particular problem, be it structural or functional in nature, that the role of a process or an element in the integrated whole cannot be understood until the interrelationships are not only appreciated but also seen in proper perspective. It is quite clear that the single-minded pursuit of a solution, to the exclusion of other aspects, has paid, and will continue to pay off handsomely in many instances; yet this unilateral approach, if not kept fully in mind and taken into account, has often led to distortion and overemphasis upon the importance of this or that feature of the cell in the maintenance and continuance of the whole. This volume therefore serves the very useful purpose of bringing under one cover a good many aspects of cell physiology which have a sound structural component inherent in them. The structural biologist, with his descriptive tendencies, has not yet been laid out in the morgue for burial, but has a real place in a rapidly advancing field. It is patently obvious, however, that the morphologist of today is a different species from the morphologist of the past. One might almost say that morphology today is the morphology of the invisible; the techniques consequently are radically different.

The volume lists 21 essays, all of which merit reading. The structural features covered include the walls, membranes, surfaces, and cytoplasmic aspects of the cell, correlated with such physiological processes as nerve conduction, fertilization, cellular synthesis, cell division, and mitotic inhibition. Any one who has kept up with the literature, however, will find that the contents of many of the essays have appeared in one form or another as reviews in previous symposia or in the various journals. Except for somewhat different ways of handling the same material, bolstered with odds and ends of newer data, the reviews of Danielli, Swann, Mitchison, Brachet, Frey-Wyssling, and Hughes, to cite the more obvious examples, provide little new in the way of information or of points of view. It would seem that the plethora of symposia held in this country and abroad has given rise to a new biological phenomenon: namely, the self-duplicating review. Rarely does a neomorph appear.

Like most volumes of this sort, this one lacks an index, thereby lessening its usefulness as a reference book. Even the discussions are omitted. Yet the volume will find a useful place in the library of the research worker, if only because of the convenience of having so much material of a similar sort close at hand.

C. P. SWANSON

THE MITOTIC CYCLE. *The Cytoplasm and Nucleus during Interphase and Mitosis.*

By Arthur Hughes. Academic Press, New York; Butterworth Scientific Publications, London. $6.00. viii + 232 pp. + 32 pl.; text ill. 1952.

Inevitably this volume will be compared with Franz Schrader's *Mitosis*, but while both deal with the same general subject matter, the approaches and content of each differ to considerable degree. While Schrader's book was an attempt, ending on a pessimistic note, to find among the mass of experimental material one or more unifying principles that would tie together the diverse expressions of mitotic structure and behavior, Hughes' volume is more a review of recent progress in the study of dividing cells. The difference in time of publication of the two volumes may account for the difference in tone, that of Hughes being optimistic as to the progress being made, but it is probably to be attributed more to the fact that Hughes is content to summarize the available data when no apparent principles are evident. Indeed, Schrader himself has been instrumental in bringing about a more optimistic point of view than had been held formerly, and it now seems likely that the physical and chemical approaches to the study of cell division are ready to yield results that will enable one to gain a more comprehensive picture of the entire process of cell division.

The volume concerns itself with the nucleic acids, the structure and chemical composition of the interphase nucleus, the dynamics of the dividing cell, and the nature of studies dealing with the stimulation and inhibition of mitosis. It stays away from problems concerned with the hereditary aspects of the cell, and leans heavily toward the physiological and somewhat less toward the descriptive aspects. In this sense it is a timely book, for despite the great revival of interest in this particular phase of cytology, and the many publications of a research nature which have appeared in the last decade, no integrated treatment has been attempted which would interest both the student and the researcher. The volume is very well documented, with the more comprehensive review papers indicated. Most topics have been approached with an open mind, and handled in a balanced fashion. Where conclusions can be drawn, this has been done; where future research is needed before generalizations can be made, this is likewise indicated. The general result is an able synthesis of the available information in a highly technical and difficult field. Each reader, no doubt, will wish that this or that aspect of the problem could have been more fully expanded, but in the opinion of the reviewer the selection and expansion of the topics is a judicious one with sufficient references provided for those who would pursue a particular topic further. The text is closely written, with a minimum of extraneous words. This makes for slow reading, but continued rereading will reveal that the author has missed little that is pertinent to his subject. It is a book to be recommended not only to cytologists, who will read it anyway, but also to biochemists, physiologists, and embryologists interested in what goes on in the cells with which they experiment.

C. P. SWANSON

GENERAL AND SYSTEMATIC BOTANY

TEXTBOOK OF THEORETICAL BOTANY. *Volume I.*

By R. C. McLean and W. R. Ivimey-Cook. Longmans, Green & Company, London, New York, and Toronto. $13.50. xv + 1069 pp. + 1 pl.; text ill. 1951.

A survey of the present knowledge of botany, with all of its many ramifications, is a monumental task, which no author or authors would undertake without trepidation. Difficulty is encountered, first of all, when the vast amount of factual knowledge is to be digested and presented in systematic and intelligible form. Greater difficulty is in the offing when hypothesis and speculation are to be met fairly and evaluated, made clear to the reader, and related in proper perspective to all problems, solved and unsolved. No single author —or two—is prepared, by virtue of personal experience, to balance rival hypotheses in such a manner as to allow the advanced student freedom of decision while at the same time giving him the factual data. A far safer approach, and one adopted by these authors, is to present with some semblance of equitable coverage the facts upon which theory and hypothesis must rest, and to leave to the lecturer and the reader the elaboration and emphasis to be placed upon speculative matter, according to one's background, interests, and convictions.

The present volume is the first of a projected 4-volume work. Its 1,069 pages indicate the enormity of the undertaking, and its major topics take in the evolutionary morphology of the lower groups from the algae through the gymnosperms, together with the anatomy of the vegetative organs of the angiosperms. Through necessity—although it is nonetheless generally ignored by most writers of botanical textbooks—an initial chapter on cytology provides the background for a detailed consideration of the changing aspects of the alternation of generations as one progresses from group to group. Examination of each major group is done by means of type species or genera rather than through a survey of the gamut of variations found in each group. This approach, of course, has the advantage of focussing the attention sharply on the singular characteristics, although diversity, if it exists, is ruled out or left to the lecturer.

In general, treatment of the groups is eminently satisfactory. The style is clear and concise, and the illustrations are numerous. Many of the photomicrographs, however, are poorly reproduced, and in some instances of insufficient magnification to be of much

value as teaching devices. The chapter on cytology is far more arbitrary than can be condoned, e.g., the statement that the presence of more than two nucleoli in a nucleus is usually a sign of polyploidy has so many exceptions as to be of no critical value. Of greater import is the fact that as a reference work—the authors refer to the volume as a textbook, but it is clearly more than that—it is completely lacking in cited references to which the student can turn for greater detail and discussion than that which the text itself affords. Possibly the authors feel that this aspect of teaching is a function of the lecturer, in which case one cannot justifiably enter a complaint. On the other hand, the size and comprehensiveness of Volume I take it out of the usual class of textbooks, and make it a reference volume. At present, it seems to be neither.

C. P. SWANSON

BOTANY OF SUGARCANE.

By C. Van Dillewijn. The Chronica Botanica Company, Waltham, Mass. $6.00. xxii + 371 pp. + 14 pl.; text ill. 1952.

This book is an exceedingly valuable monograph on an important commercial crop that has hitherto suffered from the lack of adequate reference works. The vast amount of research that has been carried on by sugarcane research institutes and individuals is here correlated and evaluated, often with more or less literal citation of original sources, both in the form of tables and statements. The extent of the coverage may be judged by the fact that 617 articles are listed in the bibliography.

The subject matter is primarily botanical, but there are many references to cane culture, pest and disease control, and breeding. Summarizing as it does the present state of our knowledge regarding sugarcane, it should be an indispensable reference work. A review of the wealth of factual material would be impossible; consequently, a mere listing of the main divisions of the work must suffice. The first section is devoted to morphology and anatomy, with chapters on the stem, bud, leaf, root, and inflorescence, together with an evaluation of vegetative characters. The second section is physiological in nature, with chapters on germination, tillering, growth, vegetative composition, chemical composition, nutrition, water, photosynthesis, and respiration. The book is adequately supplied with charts, drawings, photographs, and an index.

ALBERT F. HILL

PLANTS OF THE BIBLE.

By Harold N. Moldenke and Alma L. Moldenke. Chronica Botanica Company, Waltham. $7.50. xx + 328 pp. + 34 pl.; ill. 1952.

Religion being what it is, there is little likelihood that anyone will ever write a definitive text on biblical botany, if only for the reason that the meaning of critical Hebraic words, classical, Ashkenazi, or dialectical, is often in dispute or impossible of direct translation because of alphabetical incompatibilities. The present volume, however, will be the authoritative source for some time to come, and as such it will be of use as a reference work to botanists, Biblical scholars, and those laymen whose interests touch both fields. The result of 12 years of botanical and etymological research, the volume is undoubtedly a labor of love, involving a prodigious amount of painstaking work in tracking down words and correlating them with what is the most likely species of the particular area. Anyone who knows how common names for a single species can vary from region to region is well aware of the difficulties of tying common names with botanical species. When these difficulties are compounded by language variations, some now obsolete, the task of identification is much the greater. Even a cursory examination of the volume indicates that the Moldenkes have succeeded in presenting creditable reasons for their identifications, and these are accompanied by an excellent commentary and extensive references, both biblical and botanical. The volume is a splendid example of good writing and scholarly effort.

C. P. SWANSON

FLORA OF THE BRITISH ISLES.

By A. R. Clapham, T. G. Tutin, and E. F. Warburg. Cambridge University Press, New York and London. $9.50. lii + 1527 pp.; ill. 1951.

The British botanist John Hutchinson wrote in 1945, "there is no up-to-date British *Flora*," and A. G. Tansley called the "lack of an adequate handbook something of a national scandal." Today we have a chubby volume of over 1500 pages that came into existence like the fabled mandrake! And, like the Mandragora, no man has seen exactly its like before. Here the simile ends, for we approach this creation fearlessly, and with genuine admiration. Executed in somewhat over 3 years by 3 professors who worked on the book between teaching and other duties, this altogether admirable flora is a polestar among books of its kind. In addition to the usual description, range, and synonymy, information is given in regard to (a) flowering time, fruiting, and germination, (b) pollination, (c) seed dispersal mechanisms, (d) life forms following Raunkiaer's scheme, and (e) chromosome numbers for each species. In these several fields of unusual material lie the book's distinguishing features, which, in my opinion, mark a new departure in the writing of floras. It answers W. B. Turrill's balance sheet of a decade ago: "It is only by a combination of all methods, herbarium or museum, library. laboratory, field, and

breeding, that there is any hope of obtaining satisfactory evidence on the nature and genesis of taxonomic units."

The *Flora* has limitations, and some of these are freely acknowledged, such as the inconclusive treatment of certain genera, but a few are unfortunate, such as the circumscription of space which leaves us without useful synonymy. The line drawings are sometimes indifferently good, but we are told that a volume of illustrations is in preparation. It would have been useful to have cited the excellent line drawings and photographs of Hutchinson's pocket manuals, which have been published in the last few years. The book is printed in clear type, with good taste in the use of contrasting type fonts for comparable categories of information. The glossary, though brief, seems adequate. The appearance of such terms in the glossary as allopolyploid, hybrid swarm, fen, marsh, and moor, show the genetic and ecological accent of the *Flora*.

Large critical genera of the British flora like *Potamogeton*, *Rubus*, *Rosa*, *Salix*, *Orchis*, *Carex*, and *Hieracium*—"the most difficult taxonomically of those [genera] represented in the British flora"—have innovations in their treatment to aid in identification. For example, groups of closely related microspecies centering about a linneon, e.g., *Gentiana amarella*, are prefixed by a designation "(4–7)" referring to the species sequence which follows, and the linneon is suffixed "Agg(regate)" on a provisional basis. A sectional key is provided to the 260 apomictic forms of *Hieracium*. There are 3 keys to *Salix*: staminate, pistillate, and leaf specimens. Species of *Carex* are arranged "putting those first which show the greatest number of characters which there is reason to believe are primitive."

Happily there is no attempt to create "common names" for species that for one reason or another have never gathered folk names. Such concoctions as have been recently published in an American flora are sensibly omitted: "Small-flowered annual Indian Paint Brush,"—have we revived medieval polynomials?—"Bare Monkey Flower," or "Strickland's Tauschia," the last for *Tauschia stricklandii*. These names, to follow a Churchillian line, simply "varnish nonsense with the charms of sound." On the contrary, to record that *Nuphar lutea* is known as "Brandy-bottle"; *Galinsoga*, as "Gallant Soldier" (cf. Hutchinson, *Common Wild Flowers*, 187); and *Arum maculatum*, as "Cuckoo pint," is meaningful. Our garden *Helxine* goes in Britain under the possibly antithetical names of "Mind-your-own-business" and "Mother of thousands." Britain's houseleek, like the *Bromus tectorum* that won its specific name from its domestic habitat, is described as being about as faithful as an old sheepdog. Just how "common" is the folksy name, "Welcome home husband, however drunk you be," raises a question.

Some anomalies of the British flora may be mentioned. Normally only female plants of the Water Soldier, *Stratiotes*, occur in the islands; *Elodea canadensis* blocked waterways a century ago, then declined in abundance; two introduced *Matricaria* vie with each other as aggressive weeds, the Californian *M. occidentalis* winning in Ireland over the Asiatic *M. matricarioides;* the Pacific Coast *Mimulus moschatus*, introduced over a century ago for its interesting musky scent, has become scentless; *Buddleia davidii* is the only garden plant that turns up on bombed sites in London; the young shoots of stinging nettle are eaten like spinach—can this be adding insult to injury?

The authors of this *Flora* have truly demonstrated the fallacy of the observation reported by James Edward Smith in 1828 that "a British Flora can in future be no more than a compilation."

JOSEPH EWAN

THE PIPERACEAE OF NORTHERN SOUTH AMERICA. *Two Volumes.*

By William Trelease. University of Illinois Press, Urbana. $10.00. Vol. I: viii + Pp. 1–434 + Pl. 1–393. Vol. II: vi + Pp. 435–838 + Pl. 398–674. 1950.

This rather overwhelming work will best be appreciated by those museum taxonomists who still remember the prodigious and painful efforts of the late William Trelease, and by those field collectors from all parts of tropical America who were assured of a degree of immortality promptly upon shipping to him even a very meagre assortment of his beloved Piperaceae. For himself, a degree of immortality is certainly conferred by the phenomenal flood of new species, varieties, and forms which was not stopped even by death itself—as it now appears. To those who may doubt the wisdom of such prodigality, assurance was given by the author that the vertigo of seemingly unrelated parts would some day be resolved into a harmonious whole. That task was spared Trelease by his death, and courageously assumed by his favored student, Truman G. Yuncker.

At once the most monotonous and the most variable of plants, and omnipresent in the tropics except at the highest elevations, the Piperaceae seem to clamor for the attention of the collector on every hand. Upon my last trip to Panama, I made a resolve to collect no new species of the family—in fact, no Piperaceae whatsoever. Imagine my chagrin upon returning, therefore, to find my presses to contain not one, but actually two representative Piperaceae neatly pressed. The only possible explanation is that they themselves leapt wilfully within while my back was turned. Furthermore, they were new species. Others may corroborate my suspicions. At any rate, most tropical American collectors feel themselves outnumbered.

No more sane nor industrious man, probably, could

attempt to bring the Piperaceae of northern South America under control than Yuncker. Within these two husky, well-bound volumes will be found not only descriptions, but actually *keys*, and carefully compiled *synonymy* (!) of the 6 genera and their distributed 840 species. (I have not attempted to count the "varieties".) Furthermore, specimens are cited, usually more than one per species and occasionally quite a number (which comes as a surprise), and all are considerately indexed at the close. *Gratias sibi!* The University of Illinois Press is to be congratulated for having lavished so much money on such an unpopular cause of scholarship—particularly upon the 674 full-page photographs of type specimens which so few will appreciate, but which those few will appreciate so deeply. And to Yuncker their obligation will be unspeakable.

The minds of some of our readers doubtless will turn inexorably to the lugubrious field of statistics. Although one might be forgiven for supposing that Trelease had already unearthed all possible new species, varieties, and forms of Piperaceae extant in northern South America, these volumes give the lie to any such supposition. 419 new species alone are proposed, out of a total recognized of 840. More deplorable yet, it will be found that of those species published by Trelease previous to his death, only 25 are retained as valid, while 112 are cast into synonymy. One gathers that white settlers still are not safe.

Oddly enough, the chief fault that I find with the work is that it is not long enough—at least the 5-page introduction might be expanded to include some tentative explanation for the sorry state of affairs with which the following 833 pages are concerned. Upon turning to Darlington and Janaki Ammal's *Chromosome Atlas of Cultivated Plants*, I find that the Piperaceae appear to be a hotbed of polyploidy ($n = 4$). But perhaps such matters can be deferred to the next taxonomist who volunteers to revise this staggeringly difficult group of plants.

ROBERT E. WOODSON, JR.

THE BEST LOVED TREES OF AMERICA. *Intimate Close-Ups of their Year-Round Traits.*

By Robert S. Lemmon. The American Garden Guild and Doubleday & Company, New York. $3.50. 254 pp.; ill. 1952.

The author, in his Introduction, explains that this book is not essentially concerned with the identification of trees or how to grow them. He feels that, if the book must be classified, you, the reader, should "think of it as a book of tree appreciation written with the hope that here and there . . . you will come upon a thought or phrase or picture that will stir a responsive chord quite deep within you." Under these conditions, minor dendrological liberties with nomenclature, taxonomy, and distribution may be overlooked on the grounds of poetic license. For the same reason it is understandable that black locust and sassafras are said to have "wiggly branches"; pin oak is characterized by "astonishing twigginess"; and white pine has a "plumy beauty." The book is liberally illustrated with halftones of excellent photographic quality, depicting the trees discussed in both their winter and summer condition. Close-ups of bark, leaves, flowers, and fruits for most species are also given. Unfortunately, some of the specimens photographed are rather atypical representatives of their species (e.g., white pine and tulip-tree), suggesting that the primary attention was directed to photographic, rather than biological, considerations.

SCOTT S. PAULEY

THE TREES OF PENNSYLVANIA.

By William Carey Grimm. Stackpole & Heck, New York and Harrisburg. $5.00. xiii + 363 pp. + 1 pl.; text ill. 1950.

This book is a thoroughly illustrated popular guide to the native and important exotic tree species found in Pennsylvania. Taxonomic descriptions are brief, simplified in terminology, and confined to the principal distinguishing characteristics of the various species in their summer and winter conditions. Additional data on growth habit and habitat, commercial and ornamental value, importance as food for wildlife, etc., are included for most species. Discussion of species distribution is, unfortunately, too general, both with respect to entire range and distribution in Pennsylvania. Small range maps showing the local distribution of species by counties would have greatly improved the usefulness of the manual. The excellent drawings, all original, were done by the author, and serve to emphasize the characteristics which he found most helpful in field identification at all seasons of the year. Keys to species, based on summer and winter characteristics, are provided. Short introductory essays, How Trees Grow, The Distribution of Trees, and an illustrated discussion of the terminology used in describing leaves, flowers, and fruits, are most useful adjuncts to the text. A list of trees arranged according to families, a glossary, a list of selected references, and an index of common and Latin names are also included. This book will prove of special interest and value to nature lovers in the Keystone State.

SCOTT S. PAULEY

THE SHRUBS OF PENNSYLVANIA.

By William Carey Grimm. The Stackpole Company, Harrisburg. $5.00. xvii + 522 pp.; ill. 1952.

This book, covering the native and important exotic

shrubs and woody vines of Pennsylvania, is designed as a companion volume to the author's *The Trees of Pennsylvania* (1950), reviewed above. Organization and illustration of the shrub manual closely follow those of the one on trees; but two very worthwhile sections of introductory material have been added. One of these, on the economic importance of shrubs, tabulates information by species on site requirements, ornamental value, and importance as wildlife food. The other supplies etymological information on the scientific names appearing in the text. Unfortunate physical characteristics shared by Mr. Grimm's *Trees* and *Shrubs* are their size (ca. 8 x 11 in.) and weight (ca. 2⅛ lbs. and 3 lbs. respectively), which will doubtless tend to discourage their use in the field.

SCOTT S. PAULEY

BOTANY. *A Laboratory Manual.*

By T. E. Weier, C. R. Stocking, and J. M. Tucker. John Wiley & Sons, New York. $2.25. viii + 140 pp. + 2 pl.; ill. 1952.

This manual, with its accompanying pamphlet, *Suggestions for Laboratory Instructors*, is intended for a year's course in elementary college botany and is based on the idea that a "well-planned and stimulatingly conducted laboratory period is still the backbone of the modern college course in biology." The sequence of "events" is much like that of many other manuals, with structure and activities of flowering plants, including the study of cells, tissues, and genetics coming first, followed by a survey of the plant kingdom. Directions for laboratory work are clear and concise, questions are used liberally, and required drawings are called for chiefly as a device to call attention to important points and details. There are some good illustrations and several charts to be filled in. These charts are to serve as reviews of various studies such as those of stem anatomy, leaf morphology, flower structure, the classification of fruits, and features of green algae—to mention a few.

This seems to me to be a fairly good and usable manual, although one never knows about a manual until it has been tried out by the students. It doesn't seem particularly inspiring or original, but then I think the average instructor, unless he is lazy, uninspired, or too hard pressed, is never satisfied until he writes his own laboratory manual and even then he isn't quite happy until he has rewritten it several times.

CARROLE E. ANDERSON

PLANT GROWTH AND DEVELOPMENT

FACTEURS DE DÉVELOPPEMENT ET PRINTANISATION DES VÉGÉTAUX CULTIVÉS. *Actualités Scientifiques et Industrielles, No. 1013. Physiologie Végétale, I.*

By Roger David. Hermann & Cie., Paris. 700 fr. (paper). 177 pp. + 2 pl.; text ill. 1946.

This contribution divides itself under several heads. First there is a brief discussion on the general phenomenon of growth, followed by a second major portion which deals with development.

In the first portion there is a chapter on the biophysicochemical phenomena which condition growth. Then follows a chapter on the law of growth and a brief discussion of the existence of a physiological axial gradient. The second portion deals with what the author terms development. This he divides into a vegetative phase and a reproductive phase.

Following these general divisions is a series of chapters discussing the effects of certain factors on development, as follows: (1) the influence of light; (2) the influence of temperature; (3) stimulative effects of light and temperature combined; (4) the influence of various factors; (5) modifications of metabolism through the influences of external environment; (6) the influence of internal hormones; and (7) the several phases of development.

A third part of the work falls under the heading of vernalization. Here are discussed various techniques, experiments, and the results gained by various investigators in various localities. This portion of the treatise is concluded with a discussion of the modifications of metabolism and the hormonal complex of the plan under the influence of vernalization. The entire work is valuable especially to the agriculturist, mainly in that plants of economic importance are discussed. David, like various others, emphasizes what has come to be known as the phasic development of plants and suggests that the reproductive phase is owing to the development or existence of specialized reproductive hormones within the plants. Such statements remain, like those of other authors, and however intriguing they may be, as suggestions rather than as proofs based on objective data.

E. J. KRAUS

PLANT PHYSIOLOGY

TRACE ELEMENTS IN PLANT PHYSIOLOGY. *A Symposium Organized by the International Union of Biological Sciences with Support of UNESCO at the Rothamsted Experimental Station, Rothamsted, Harpenden, Herts., England, November 5–6, 1947. Lotsya, Vol. 3—I.U.B.S. Colloquia, Series B., No. 1.*

Report of the Proceedings by T. Wallace; Foreword by M. J. Sirks; 14 contributors. Chronica Botanica Company, Waltham, Mass.; Stechert-Hafner, New York. $4.50 (paper). xx + 144 pp. + 10 pl.; text ill. 1950.

This book contains papers dealing with the applied aspects of the trace element requirements of plants and animals. The symposium was held at Rothamsted

Experimental Station, England, in 1947, and it is to be regretted that 3 years should have elapsed before publication of this useful summary of the wartime investigations carried out in European and American laboratories. Professor Wallace, besides contributing a paper, has assembled and edited the contributions. These include descriptions of techniques for studying and determining trace metal deficiencies in plants, and studies of the interrelations of micronutrient elements in the nutrition of fungi, higher plants, and farm stock.

This is a useful account of the research work done up to 1947. Important additional work on micronutrient deficiencies in plants and animals has been done since then, so it is to be hoped that this will be the first of a series of periodic conferences of research workers engaged in this important field.

D. J. D. NICHOLAS

TRACE ELEMENTS IN PLANTS AND ANIMALS. *2nd Edition.*

By Walter Stiles. Cambridge University Press, New York and London; [The Macmillan Company, New York]. $3.00. xii + 189 pp. + 7 pl.; text ill. 1948.

This book provides an elementary survey of the trace metal nutrition of plants and animals. After a brief historical section, the author discusses the methods used in determining mineral nutrients in biological tissues and then describes symptoms of trace metal deficiencies in plants and animals. A brief section is devoted to the function of trace metals in plant and animal nutrition.

Notable progress has been made recently in this area of research, so that some statements are already out of date. No mention is made of (1) the use of chelating agents for purification of media for pure culture work, (2) the sensitive bioassay methods for determining trace metals in biological materials, or (3) recent work on the role of micronutrient elements in enzyme systems. It is clear that a book of this kind must be reviewed and some sections rewritten periodically to keep abreast of the numerous advances made in this important field. (See *Q.R.B.*, 22: 337. 1947).

The book provides a well written summary of the work done on trace metal nutrition of plants and animals up to 1948 but is not sufficiently detailed for the specialist.

D. J. D. NICHOLAS

DORMANCES ET INHIBITIONS DES GRAINES ET DES BOURGEONS, PRÉPARATION AU FORÇAGE: THERMOPERIODISME.

By Pierre Chouard. Centre de Documentation Universitaire, Paris. 600 fr. (paper; mimeographed). v + 157 pp.; ill. 1951.

Under this somewhat ponderous title Chouard has assembled a lively and well-documented discussion of one of the most active fields of plant physiology. The phenomena of dormancy and growth inhibition, always of interest both to physiologists and to horticulturists, have attracted greatly increased attention since the discovery that they can be brought about by known substances in definite concentrations. Thus the inhibition of buds is caused by indole acetic acid or other auxins acting in the plant, and can readily be imitated by applying such substances; the dormancy of seeds can be imitated by coumarin and other unsaturated lactones, and may indeed be due to these or similar lactones in the intact seed. If the dormancy of tubers and corms cannot yet be ascribed to a specific substance, it can at least be overcome by known compounds like thiourea and ethylene chlorohydrin. Winter dormancy of buds of trees and shrubs behaves somewhat similarly. Then there is what Chouard calls the "diapause of maturation," or dormancy of immature seeds, whose embryos will begin growth if isolated from the endosperm. This type of dormancy is ascribed to substances diffusing from the maternal tissue. These and many other phenomena are described and classified. Since in many cases dormancy is strikingly affected by heat and cold, Chouard goes on to give a valuable review of the work of Blaauw on the control of development in bulbs by temperature treatments, and, more briefly, of the recent studies of the diurnal thermoperiodic requirements of a number of plants.

In a concluding theoretical section, an attempt is made to summarize the various theories of the action of auxin, and of their possible interrelation with that of the lactones. The discussion, throughout, is mainly physiological rather than biochemical. A clear distinction is made between *inhibition*, which ceases when the inhibitor is removed, and *dormancy*, which is due to causes within the organ itself. In a discussion of the mechanism of bud inhibition, Chouard adds a new proposal to the nine or ten which are already in the literature. He visualizes the inhibition as probably a dual phenomenon, the buds being first held back by inhibitors coming from the leaves, non-polar in their movement; under this influence not only is growth retarded, but the polarity of the transport of auxin in the bud tissues is also suspended, so that auxin which is in the stem penetrates upwards into the buds and further inhibits their growth directly.

The bibliography ranges from 1877 to 1950. Since so many of the papers, especially those of the last 15 years, are in English, the book should be of great value to French-speaking students. In this country it should be very useful for graduate students learning scientific French, for the style is clear and cursive. It may also be found useful in Latin America, where there is marked and increasing interest in this field.

KENNETH V. THIMANN

ECONOMIC BOTANY

PRACTICAL PLANT BREEDING. *Third Edition.* *By W. J. C. Lawrence; Foreword by Sir Daniel Hall. George Allen & Unwin, London.* $2.00. 166 pp.; ill. 1951.

The present edition of this small but excellent textbook on the theoretical as well as the practical aspects of plant breeding differs from the earlier ones in that consideration is given to the colchicine techniques for producing polyploid varieties, and to special breeding techniques used on chrysanthemums, dahlias, roses, sweet corn, onion, and tomato. The breeder, whose interests may be for profit or for pleasure, will find this an understandable and useful volume.

C. P. SWANSON

PRINCIPLES OF FIELD CROP PRODUCTION. *By John H. Martin and Warren H. Leonard. The Macmillan Company, New York.* $6.00. x + 1176 pp.; ill. 1949.

This is an excellently printed and illustrated book designed, according to the authors, as a college textbook for a general course in field crops. It should also serve as a reference work to those concerned with practical crop production. They admit that the book is longer than can usually be covered in a one-semester course, and state that it offers a choice of subject matter to meet different institutional and local requirements, and that since the subject matter is of national scope it should be supplemented with lectures or assigned readings on local crop varieties and cropping practices. Each chapter has a list of references to useful pertinent papers in American technical journals, to State Experiment Station, or to U. S. Department of Agriculture publications. Fortunately, there are remarkably few references to secondary sources. The principles of field crop production comprise only about one quarter of the book under review, while a discussion, crop by crop, of the members of the grass family makes up another quarter, that of leguminous crops about a sixth, and that of crops of other plant families another sixth. An extensive appendix of useful tables, a glossary of technical terms, trade names, etc., comprise a final sixth.

It would seem from the treatment sketched that considerable changes, either in the scope of the book or in its title, are called for. As the authors state, staple agricultural crops show a marked tendency to geographic segregation. A treatment on a regional basis would justify and make desirable a somewhat more categorical treatment of a number of the crops, at least for that region. Is it wise to attempt a national scope or treatment when the ecological and hence agronomic practices which must be applied vary so much within the continental United States? While it is always difficult to draw satisfactory boundaries, as between the principal crop regions of the United States, it seems that regional treatments of the subject would have permitted a somewhat more specific handling of each crop, and would have given space for some stimulating comparisons with agronomic practices in other parts of the world. Rice has already been treated on a regional basis; it would seem that in view of the uniqueness and peculiar world importance of this crop, that rice especially could have been so handled with profit. It thus seems that the general principles of crop production might best be treated in a separate book in which the text of certain portions, such as soils, would be less conventional, but would include more of the recently developed concepts. Then the various field crops could be covered on a regional basis, with a book for each region, one or two volumes of which would be more appropriate for agricultural college students in any one region. The entire set could well comprise a reference work for the progressive farmer.

An interesting but hardly appropriate feature of this book, in its present ponderous form, is how the field crops are utilized industrially, or are prepared for human food on a modern manufacturing scale. For example, under barley there is a considerable discussion of brewing, with some additional information under hops of the brewing processes; and under wheat there is a considerable discussion of flour milling and baking characteristics. As a whole, the make-up of the book is excellent, although the chapter running heads are so far to the left that part of their utility is lost because they are difficult to see.

ROBERT L. PENDLETON

IRRIGATED SOILS: *Their Fertility and Management.* *By D. W. Thorne and H. B. Peterson. The Blakiston Company, Philadelphia and Toronto.* $5.00. x + 288 pp.; ill. 1949.

This book is an outstanding achievement in presenting clearly and simply the basic principles of the fertility and management of the semi-arid and arid soils of the western and southwestern United States. A regional emphasis is appropriate because in this vast region the problems of salt accumulation, high alkalinity, and excessive lime accumulation are in direct contrast to the leaching, soil acidity, and liming problems of the soils of the humid regions of the United States. Almost without exception, textbooks on soils have a bias in favor of the humid region soils. This textbook, on the contrary, covers practically the whole range of soil fertility and management problems of arid and especially of irrigated soils and crops, and their appropriate agronomic practices and fertilizers. Especial emphasis is placed upon the careful control of irrigation

practices so that the persistent problems of erosion, waterlogging, salt accumulation, soil permeability and aeration, and soil depletion can be controlled. Padi (lowland rice) irrigation and agronomy are discussed, but quite inadequately. The uniqueness of the padi plant in its needs and tolerances as to nature and depth of water, and as to the physical and chemical characteristics of the soil which make this crop peculiarly fitted for the leached, impoverished soils of humid tropical and subtropical regions, preclude any satisfactory treatment of this crop within the scope of the book under review. Helpful are the older and modern classifications of salted and alkali soils. Soil water and plant relations are considered, especially in relation to saline and alkali soils. Useful bibliographies conveniently follow each chapter. The running heads are also useful, with the chapter titles repeated on the left, and the immediate subject on the right. The format is good, with double columns of easily read type, and with clear graphs and illustrations. This work should prove to be an invaluable handbook for every farmer in the arid and semi-arid regions of the western United States. It is a pity that botanical names have not been included more generally for the less common crops and other plants, so that the information would have a much wider application. For many a suburban resident in those regions, the short chapter on soil management around the home should be worth more than the cost of the book.

ROBERT L. PENDLETON

MANUAL OF RICE DISEASES.

By G. Watts Padwick. Commonwealth Mycological Institute, Kew, Surrey, England. £1 10s.; $4.50. viii + 198 pp.; ill. 1950.

This book brings together a vast amount of information from diverse sources on diseases of rice. As stated by the author, it is neither a textbook nor a monograph. It is a valuable reference book, especially since much of the literature on rice diseases either is not readily available or is in languages that many western scholars cannot read.

The book is divided into 3 parts. Part I (115 pp.) includes diseases of parasitic origin, with a detailed discussion of 28 diseases caused by bacteria, fungi, and nematodes. Part II (17 pp.) discusses non-parasitic diseases caused by unfavorable soil conditions, deficiencies, and viruses. Part III (57 pp.) gives an annotated check-list of more than 200 fungi recorded as parasitic on rice. The text contains 46 line drawings. Literature references are given following the discussions of each disease; for the major diseases the lists are very comprehensive. Virtually all known rice diseases are included in the book. Those of major importance are discussed in detail, including their history, geographical distribution, etiology, and control. The author also has attempted to summarize available or pertinent information regarding little-known or relatively unimportant diseases.

Because many papers have been published on diseases of rice in different languages, the author has done an excellent job in condensing this material into a small book.

J. J. CHRISTENSEN

DISEASES OF CEREALS AND GRASSES IN NORTH AMERICA. (*Fungi, Except Smuts and Rusts.*)

By Roderick Sprague. Ronald Press Company, New York. $7.00. xvi + 538 pp.; ill. 1950.

This manual of the diseases of those crops was written, as the author states in the preface, "... to supply a source of centrally assembled information concerning the fungi occurring on members of the grass family." The manual discusses 384 species and subcategories of species of fungi parasitic on members of the grass family, and includes some associated saprophytes. The fungi are listed alphabetically under the 4 classes of fungi: (1) Phycomycetes, (2) Ascomycetes, (3) Basidiomycetes, (4) Fungi Imperfecti.

The greatest value of the book is as a reference work. It is well supplied with references for each organism discussed, to a total of 80 pages of literature citations. Some of the major organisms and diseases are discussed in some detail, briefly though concisely. *Rhizoctonia solani* and diseases caused by *Pythium* species are examples of the latter.

The manual should serve well as a tool in the identification of organisms and diseases associated with the Gramineae. Descriptions of organisms are the originals and therefore exact. Descriptions of the diseases are adequate for identification. Keys are given for the identification of genera and species in each class of fungi. Exhaustive indexes to hosts are given for each fungus species. The author selected many of the best illustrations of fungi, but it is unfortunate that there are no illustrations of diseased plants.

The manual, being of a specific nature, will be useful primarily to the specialist in diseases of cereals and grasses, and the specialist in these diseases cannot afford to be without a copy of the book.

M. F. KERNKAMP

DISEASE IN PLANTS. *An Introduction to Agricultural Phytopathology.*

By the late Neil E. Stevens and Russell B. Stevens. Chronica Botanica Company, Waltham, Mass.; Stechert-Hafner, New York City. $4.75. xx + 219 pp. + 2 pl.; text ill. 1952.

This volume endeavors to present the "body of knowledge and a point of view which is common to plant pathology and plant disease problems everywhere." As such it represents a departure from most textbooks of plant pathology, which deal with a selected number of plant diseases in detail. The subject matter is here organized into 20 chapters, the introductory ones dealing with plant diseases in relation to human welfare, the effects of diseases on plants, and the nature of viruses, bacteria, fungi, flowering plants, nematodes, insects, and non-parasitic agencies which result in the causation of plant disease. This is followed by a section dealing with the characteristics of the host, the pathogen, and the environment which modify disease development. The concluding section is devoted to disease control, through chemical treatment, crop rotation, eradication, quarantine, and the breeding of varieties for disease resistance. The book should be required reading for all students of plant pathology.

F. T. WOLF

FORESTRY AND ITS CAREER OPPORTUNITIES.

By Hardy L. Shirley. McGraw-Hill Book Company, New York, Toronto and London. $6.50. ix + 492 pp.; ill. 1952.

This book is based on a series of lectures presented by H. L. Shirley in a course in general forestry for freshmen at the State University of New York's College of Forestry. In the words of the author, its purpose is "to present a broad picture of forestry in relation to its historic development and its place in national and world economy . . ." and thus to "help beginning students to understand the many facets of forestry and to give them background for deciding if forestry is to be their life career." By means of a clever combination of detail and generalization, this objective is achieved. *Forestry and Its Career Opportunities* should be read by every prospective forester. Even those professional foresters whose freshman forestry days are long past cannot, in some measure, fail to profit by reading this book.

SCOTT S. PAULEY

GENERAL AND SYSTEMATIC ZOOLOGY

ILLUSTRATED KEY TO WEST NORTH AMERICAN GASTROPOD GENERA.

By A. Myra Keen and John C. Pearson. Stanford University Press, Stanford, Cal. $1.50 (paper). 39 pp.; ill. 1952.

This is a companion to the analytical key to the Pelecypoda by Keen and Frizzell, published some years ago. The present work is well illustrated, with holotypes of 2 species not previously figured, and systematic and alphabetic indices of generic names.

FLORIDA MARINE SHELLS. *A Guide for Collectors of Shells of the Southeastern Atlantic Coast and Gulf Coast. By C. N. Vilas and N. R. Vilas. The Bobbs-Merrill Company, Indianapolis and New York.* $4.00. 170 pp.; ill. 1952.

This work is essentially a piece of propaganda—to excite an interest in shell collecting among those (if there are such in these days) on whose hands time hangs heavily. It will be found helpful by beginners, but its greatest field of usefulness will be to those who are not yet beginners, but who, having retired from other activities, are now looking for a field to which they can turn their attentions. We need more books of this sort, covering both coasts of the United States as well as the interior of the country.

JOSHUA L. BAILY, JR.

THE FALSE SPIDER MITES OF CALIFORNIA (ACARINA: PHYTOPTIPALPIDAE). *Univ. Calif. Pub. Entom., Vol. 9, No. 1. By A. Earl Pritchard and Edward W. Baker. University of California Press, Berkeley and Los Angeles.* $1.00 (paper). iv + 93 pp.; ill. 1951.

This is a fine systematic study of a family of mites which contains a number of more or less serious pests of ornamental plants, shrubs, and trees. Preliminary to the taxonomic treatment is a short but adequate account of the chaetotaxy and salient anatomical features. Forty species, among 5 genera of phytoptipalpids, are dealt with. Of these, 24 are described as new, and, in addition, 7 new synonyms are recognized.

All valid species are separated by one or more dichotomizing keys, both sexes and immature stages of new species are described, and all 40 species are admirably figured. Of special interest to biologists is the description of a gynandromorphic *Brevipalpus asthenes*; and, when compared with other members of the genus, the curious reversal of *Tenuipalpus pacificus*' preferred position to the *upper* surface of host leaves.

KENNETH W. COOPER

THE GRASSHOPPERS AND LOCUSTS (ACRIDOIDEA) OF AUSTRALIA. *Vol. 1. Families Tetrigidae and Eumastacidae. By James A. G. Rehn. Commonwealth Scientific and Industrial Research Organization, Melbourne.* £2 0s. 0d. 326 pp. + 21 pl.; ill. 1952.

From time to time a taxonomic monograph is published whose importance transcends the particular group of organisms or geographic area with which it deals. It seems likely that this will be the case with the present work, of which only the first volume has appeared so far (the complete opus will in all probability include six or seven such volumes, of which several are known to be in an advanced state of preparation). The economic significance of grasshoppers and locusts is considerable in all the continents and not least in Australia; and their importance in genetic, cytological, physiological, evolutionary, and ecological studies seems to be continuously increasing. Of all the general problems of zoogeography, that of the origin and evolution of the Australian fauna is one of the most fascinating. It is, therefore, fortunate that Rehn, the Curator of Insects at the Academy of Natural Sciences of Philadelphia, after 50 years of orthopterological studies, should devote himself to the preparation of a general taxonomic monograph of the Australian Acridoidea. Certainly the Commonwealth Scientific and Industrial Research Organization is to be congratulated on the liberal and far-sighted policy which has made this undertaking possible.

Knowledge of the Australian grasshopper fauna has until now been based mainly on two monographs by the Swedish entomologist Sjöstedt, whose work was unsatisfactory and inadequate in many respects. In 1935 Sjöstedt listed 488 species, subspecies, and "varieties" of Acridoidea from Australia and Tasmania. Since that time, a considerable collection of Australian Orthoptera has been built up in Canberra, largely through the activity of K. H. L. Key, of the Division of Entomology, C.S.I.R.O., and it is this material which has formed the main nucleus of the present revision. It now seems probable that when the complete work is finished, the number of species recognized will be almost doubled. In the first volume, which deals with the grouse locusts (Tetrigidae) and the eumastacids, 16 new species of the former and 23 of the latter are described. In addition, four new genera of tetrigids and two of eumastacids are characterized. It is noteworthy, however, that of the new species no less than 15 are described from single individuals and more than half are known only from one sex. These facts by no means diminish the value of the work, but do indicate that the Australian tetrigid and eumastacid fauna is even now imperfectly known and that a considerable number of species probably still awaits discovery. The situation in the family Acrididae is doubtless similar. Taking this into consideration, it seems likely that the total number of species of Acridoidea in Australia (both known and unknown) is probably well over a thousand, i.e., about twice the number known to inhabit the United States (an area of approximately the same size). The reasons for this richness of the fauna are not difficult to appreciate. Grasshoppers inhabit a great variety of ecological habitats, from the most humid to the most arid, and are consequently found in all parts of the Australian continent. No doubt the interrelationships of the various subfaunas will become much more apparent as Rehn's work progresses. But it is already clear that two distinct groups of forms inhabit the temperate and mesic areas of southeastern and southwestern Australia, separated by a rich desert fauna in the central part of the continent; while in Queensland and the Northern Territory a tropical fauna of Papuan affinities exists.

The grouse locusts are especially noteworthy for the variety of color patterns present in the natural populations of many species. Geneticists will be interested to learn from this volume that the color phases in the Australian *Paratettix australis* and *argillaceus* closely parallel those of *Paratettix texanus*, whose inheritance was studied by Nabours in this country. In all these species the majority of the population are rather uniformly dull in color, and Nabours has shown that such individuals are homozygous for a gene which is recessive to the numerous alleles that determine the striking color patterns present in the remainder of the population. Although no genetic work has been carried out on the Australian species, there can be little doubt that the genetic mechanism is similar and its significance in the population dynamics of the species probably the same.

The Tetrigidae contain a few genera, such as *Tetrix* and *Paratettix*, whose distribution embraces several continents, and a large number of genera of much more restricted distribution, several of which are endemic in eastern Australia, together with a few peculiar types in western Australia. The Australian Eumastacidae, on the other hand, consist of two subfamilies, the larger of which is entirely endemic, while the other is also present in New Guinea and the Aru Islands. Several characteristic Oriental and Indomalayan subfamilies of the Eumastacidae which are present in New Guinea do not seem to have reached Australia.

To those who are familiar with the author's methods, the completeness of the taxonomic descriptions in the present work will not come as a surprise. A considerable amount of information concerning the distribution of the species has been supplied by Key. The work as a whole will undoubtedly be an important contribution to our understanding of the classification of the Acridoidea as well as to the zoogeography of Australia.

M. J. D. White

The Generic Names of the Beetle Family Staphylinidae, *with an Essay on Genotypy. Smithsonian Inst. U. S. Natl. Mus. Bull. 200.*

By Richard E. Blackwelder. Government Printing

Office, Washington. $1.50 (paper). iv + 483 pp. 1952.

Generic names for insects have often been chosen haphazardly in the past and are a constant source of trouble to the taxonomist who wants to stay in accord with the International Rules of Nomenclature. The present monograph presents a thorough study of the generic names of the Staphylinidae based on a critical review of the literature. This is preceded by a statement of the author's view on the exact way the Rules of Nomenclature should be interpreted for the generic names of the past. (There is much less difficulty for recent names proposed since the Rules were accepted.) This helps a great deal to clarify the issue even if some authorities should not agree on all points.

The list of generic names of Staphylinidae, 382 pages long, which forms the main body of the paper gives all the information available about the status of generic and subgeneric names ever proposed for this family, such as the genotype, when and how it was fixed, synonyms, homonyms, variant spellings, etc. Another table, arranged in systematic order, gives a key to the changes made necessary in the current generic nomenclature by the author's analysis. There are many such changes even among the most familiar names. For instance the name *Staphylinus* belongs properly to the genus now usually called *Creophilus* because Latreille in 1810 designated *Staphylinus maxillosus* Linné as type of *Staphylinus*. The genus now called *Staphylinus* (type *stercorarius* (Olivier)) must be called *Platydracus*. Whether all changes proposed by Blackwelder will be accepted is another matter, but this is not so very important. The value of the paper is that the issues are now clear and can be decided on their merits.

Many taxonomists will wish that they had at their disposal a study such as this one for their particular group. Very few persons, however, have the wide knowledge of the literature and the patience of Blackwelder to carry such an undertaking to a successful conclusion.

G. H. DIEKE

A REVISIONAL STUDY OF NEOTROPICAL PSELAPHID BEETLES. *Special Pub. No. 9, Part 2, Tribe Euplectini sensu latiore.*

By Orlando Park. The Chicago Academy of Sciences, Chicago. Pp. 53–150; ill. 1952.

A monograph for specialists. Keys are given for all known genera and species, detailed descriptions for the numerous new species. The great increase in the number of species is due to the fact that collections from leaf debris and soil were available. Drawings present structural details.

G. H. DIEKE

THE TORTOISE BEETLES OF CHINA (CHRYSOMELIDAE: CASSIDINAE). *Proc. Calif. Acad. Sci., 4th ser., Vol. 27, No. 17.*

By J. Linsley Gressitt. California Academy of Science, San Francisco. $2.50 (paper). Pp. 433–592; ill. 1952.

A monograph of this subfamily occurring in greater China. Keys to genera and species, as well as to known larvae and pupae, life histories, distribution maps, figures of adults and immature stages, parasites, etc. Contains 91 species, 9 of these and 2 subspecies new. A very thorough study.

G. H. DIEKE

SPHECIDAE AND POMPILIDAE (HYMENOPTERA) COLLECTED BY MR. K. M. GUICHARD IN WEST AFRICA AND ETHIOPIA, 1941–1948. *Bull. Brit. Mus. Nat. Hist., Ent., Vol. 2, No. 3.*

By G. Arnold. The British Museum, London. 15s. (paper). Pp. 95–183 + pls. 4–5; text ill. 1951.

G. Arnold's monograph reports the taxonomic evaluation of nearly 700 sphecid and 162 pompilid wasps collected in little known regions of Africa. The 30 genera of sphecids, of which the larrine *Phytosphex* and *Odontosphex* are here first described, include among them some 141 named forms, of which 58 are new. *Phytosphex turneri* (Arnold) will interest biologists, for it markedly departs from the usual larrine habit of nesting in subterranean burrows or under stones, and instead chooses hollow stems of plants and forms partitions of earth and small pebbles between its cells.

The pompilids represent 45 named forms, scattered among 18 genera, of which *Guichardia* (genus), *Pilompus* (subgenus of *Pompilus*), and 11 species and 1 subspecies are new. As in the past, Arnold continues to aid his readers with welcome delineations of the more subtle systematic characters, and careful specification of the least magnifications required to resolve important sculpture.

KENNETH W. COOPER

FLOUNDERS OF THE GENUS PARALICHTHYS AND RELATED GENERA IN AMERICAN WATERS. *U. S. Fish & Wildlife Service, Fishery Bull. 71.*

By Isaac Ginsburg. U. S. Government Printing Office, Washington. 60 cents (paper). Pp. 267–351; ill. 1952.

AMPHIBIENS ET REPTILES. *Fasc. I. Atlas des Vertébrés. New Edition.*

By F. Angel. Éditions N. Boubée & Co., Paris. 400 fr. 129 pp. + 12 pl.; ill. 1949.

AMPHIBIENS ET REPTILES. *Fasc. II. Atlas des Vertébrés. New Edition.*

By F. Angel. Éditions N. Boubée & Co., Paris. 400 fr. 141 pp. + 12 pl.; ill. 1949.

A hundred years ago the French led the world in producing comprehensive accounts of general natural history. This tradition has not been lost, and in modern times there is a renewal of this interest, witnessed by a new comprehensive treatise on zoology, which is in progress, and by more popular accounts of various groups of animals, like the work under review.

One picks up the work named in the expectation, from the format of the two volumes and from the cover illustrations, to find another of the endless small popular accounts of the fauna of France. To open them is to discover instead a neat little conspectus of the amphibians and reptiles of the world, with excellent coverage of the principal families of amphibians and reptiles, and with much new illustration. These little volumes are to be recommended as easy lessons in zoological French as well as in elementary herpetology to every would-be herpetologist.

KARL P. SCHMIDT

A BIBLIOGRAPHY OF THE HERPETOLOGY OF JAPAN. *Bull. Amer. Mus. Nat. Hist., Vol. 93: Art. 6.*

By Carl Gans. American Museum of Natural History, New York. $1.25 (paper). iv + pp. 393–496. 1949.

Gans' *Bibliography of the Herpetology of Japan* is a work so conscientiously carried out, so useful for its translations of titles from the Japanese, and so useful also for bringing together the titles for one of the herpetologically notable faunal regions, that it seems ungenerous to belabor the complexity of his symbolism or other features of form in which his bibliography is at variance with the principles laid down in 1917 by Charles Lewis Camp and myself in our manuscript *Working Guide for a ... Bibliography of Herpetology.* It is to be regretted that some evaluation of the papers listed could not be included, and I miss especially the enumeration of plates and figures, since these may be useful to the non-Japanese, independently of the text. The frog-farming literature seems to have been omitted. Above all, it is unfortunate that there can be no clue in so formal a list to the romance and human interest concealed under the names Victor Kuehne and Joseph C. Thompson. The story of the life-long interest of Leonhard Stejneger in oriental herpetology is implicit in the *Plan for a Biological Survey of the Palearctic Region*, by himself and Gerritt S. Miller, Jr. (1902).

KARL P. SCHMIDT

HANDBOOK OF TURTLES. *The Turtles of the United States, Canada, and Baja California.*

By Archie Carr. Comstock Publishing Associates, a division of Cornell University Press, Ithaca. $7.50. xv + 542 pp.; ill. 1952.

Carr has done a beautiful job in preparing this informative volume on American turtles. Since the book is an addition to the series of Handbooks of North American Natural History, published by the Comstock (Cornell) Press, it invites comparison with the other herpetological volumes. Carr on turtles has, at once, the interesting personalized appeal of Wright on frogs, the scientific meticulousness of Bishop on salamanders, and the wealth of information of Smith on lizards.

Under various headings, such as Range, Distinguishing Features, Description, Habitat, Habits, Breeding, Feeding, and Economic Importance, Carr gives the essence of what is known about the 79 forms of turtles he recognizes from the U. S., Canada, and Baja California. He does best with the species with which he is most familiar, these being the marine forms and those occurring in the southeastern states. The ranges of all the races are shown on maps, and there is also included a series of good illustrations. Effective line drawings are used to point up certain aspects of the text. A revised terminology of osteological and epidermal characters, adapted from Stejneger, and a very brief biology of turtles constitute an informative introduction. A few persons may find fault with certain of his allocations—a matter which will be further considered by other specialists. A number of persons may consider the author's style too breezy for this kind of book; I find it refreshing. The *Handbook of Turtles* can be recommended without reservation to both casual and professional readers.

ARNOLD G. GROBMAN

TESTUDO CUBENSIS AND THE EVOLUTION OF WESTERN HEMISPHERE TORTOISES. *Bull. Amer. Mus. Nat. Hist., Vol. 95, Art. 1.*

By Ernest Williams. American Museum of Natural History, New York. 75 cents (paper). Pp. 1–36 + 8 pl.; text ill. 1950.

This is a systematic review of the fossil and living tortoises of the western hemisphere. Although the living genera include only *Testudo*, best known from the Galapagos Islands, and *Gopherus* of the southern part of the United States and adjacent Mexico, the number and extent of fossil genera is considerable. After a discussion of the morphology, taxonomy, and evolution of the tortoises, emphasizing the West Indian material, Williams lists 7 fossil genera (containing 78 forms) which ranged from Saskatchewan to Patagonia.

ARNOLD B. GROBMAN

THE MAMMALS OF VICTORIA *and The Dental Characteristics of Monotremes and Australian Marsupials. National Museum of Victoria, Australia, Handbook No. 1.*

By C. W. Brazenor. Brown, Prior, & Anderson, Melbourne. 7s. 6d. 125 pp. + 1 pl.; text ill. 1950.

This book answers the demand for a handbook of the mammals of the State of Victoria, Australia. It is divided into 2 parts, the first of which deals with the native and introduced species found in Victoria or its surrounding waters. Approximately 1 page is devoted to each species, most of which is taken up with a pen-and-ink sketch of the animal, the remainder consisting of a brief account of recognition features, preferred habitat, nest, food, and sometimes distribution and abundance. The occasional use of such terms as "woolly-but country" will be unenlightening to most non-Australians. The second part of the book, which is segregated from the first by the Index, contains a review of the dental characters of monotremes and marsupials, with examples chosen to show progressive specialization. The species selected as examples are not necessarily Victorian.

The brevity of discussion and the failure to include pertinent information in the species discussions hardly recommend the book to non-Victorian readers. However, the parts dealing with the "milk-versus-permanent-dentition" controversy concerning marsupial teeth, the discussion of marsupial reproduction and the variations in the female genitalia, and above all the lifelike drawings by G. J. Browning will find favor with interested persons everywhere.

BRYAN P. GLASS

ZOOLOGY.

By Alfred M. Elliott. Appleton-Century-Crofts, New York. $6.00. x + 719 pp.; ill. 1952.

This new and handsome textbook is a worthy addition to the growing list of elementary zoology textbooks. Its organization seems one of the best I have ever encountered. The central biological principle that has been used to coordinate the entire field of zoology is evolution, and to that principle the student is continually referred. Consequently the evolutionary development of organisms, beginning with the early history of life, the formation of cells, and unicellular and multicellular organisms, is taken up in orderly sequence. The culmination with the chordates leads directly to the anatomical and physiological study of man. Reproduction leads to growth and heredity. Finally, the entire material is brought together again by a discussion of evolution and its mechanism. An index, glossary, list of references, and a classification of the animal kingdom come at the end.

The page format consists of 2 columns and the entire book is profusely illustrated with drawings and photographs. These drawings will undoubtedly be an important selling point of the book and therefore need to be described further. Most of them are diagrammatic emphasizing the salient point they are meant to put across. Others are pictorial, somewhat humorous—including little men performing various antics—and a few are strictly anatomical. All are original and many are unique in concept. Artistically, some are peculiar. Some of the diagrams are so involved that only careful study will unravel their meaning. In other words, there is a wide variation, some illustrations being more successful than others, although when averaged their story is conveyed better than by any other set of similar drawings I know. The photographs are very good.

The only matter for doubt lies in the coverage of the subject matter. One can admire the way in which the author has eschewed a superficial coverage—but it is difficult to see how a mixed group of beginning students could possibly hope to cover and absorb all the material offered. Considerable material might have been successfully eliminated without damaging any of the objectives of an elementary course in zoology. All zoology teachers are urged to make a careful examination of this textbook.

HENRI C. SEIBERT

ECONOMIC ZOOLOGY

INDO-PACIFIC FISHERIES COUNCIL. PROCEEDINGS, 3RD MEETING. 1ST–16TH FEBRUARY, 1951, MADRAS, INDIA. *Section II and III.*

Indo-Pacific Fisheries Council, Bangkok, Thailand. Pp. 61–227 + 2 pl.; text ill. 1952.

Section II consists of technical papers on various subjects, from river pollution to developmental stages in a crustacean (*Metapenaeus*). Section III is a symposium on problems of fish introduction and transplantation in the Indo-Pacific region.

FISH-CULTURE IN BRACKISH-WATER PONDS OF JAVA. *Spec. Pub. No. 1.*

By W. H. Schuster. Indo-Pacific Fisheries Council, Bangkok, Thailand. xii + 143 pp. + 25 pl. + 1 folded map; text ill. 1952.

(First published in Indonesia, September, 1949, under the title *De Visculture in de Kustwijvers op Java*, as Pub. No. 2 from the Inland Fisheries Division of the Department of Agriculture and Fisheries.)

This is not a routine treatise on pond culture, but a significant ecological and sociological study of the culture of *Chanos chanos* in artificially constructed tidal ponds. It will interest not only ecologists who

may be particularly interested in brackish water problems, but the planners who have their sights on a greater utilization of the resources of the sea.

JOEL W. HEDGPETH

THE COMMERCIAL FISH CATCH OF CALIFORNIA FOR THE YEAR 1950, *with a Description of Methods Used in Collecting and Compiling the Statistics. Fish Bulletin No. 86.*

By the Staff of the Bureau of Marine Fisheries. State of California Department of Fish and Game. Free upon request. 124 pp. (paper); ill. 1952.

DISTRIBUTION AND ABUNDANCE OF YOUNG SARDINES (*Sardinops caerulea*). *Surveys Through 1951. Fish Bulletin No. 87.*

By Julius B. Phillips and John Radovich, Bureau of Marine Fisheries. State of California Department of Fish and Game. Free upon request. 67 pp. (paper); ill. 1952.

BEEF CATTLE. *Fourth Edition.*

By Roscoe R. Snapp, with a chapter on Sterility by Harry Hardenbrook. John Wiley & Sons, New York. $6.50. xiv + 641 pp.; ill. 1952.

This is the 4th edition of a book long popular with college students of animal husbandry and beef cattle producers. When first written in 1925, its major emphasis was placed upon beef cattle problems peculiar to the Corn Belt States. The new edition covers in a broad way the production of beef cattle in all parts of the United States. The author has divided the text into 4 general sections. The practical nutritional requirements and systems of fattening cattle for market are dealt with in 15 chapters. Nearly every feed used in cattle-feeding is discussed. Results, both new and old, obtained at experiment stations throughout the United States are presented. Other sections dealing with the breeding herd, general problems of cattle distribution, economics, cattle showing, buildings and equipment, diseases, and parasites are discussed in far less detail than the section on feeding. As a result, the discussion of minerals, vitamins, drugs, hormones, and antibiotics in a single chapter, or of sterility in 7 pages, seems too brief to suit specialists in these fields. This criticism was anticipated by the author, who points out that in order to include the great volume of new information on feeding, some other topics have been greatly condensed or even omitted.

FREDERICK N. ANDREWS

PRINCIPLES OF MILK PRODUCTION.

By William Barbour Nevens. McGraw-Hill Book Company, New York, Toronto, and London. $5.00. ix + 443 pp. + 1 folded chart; text ill. 1951.

This book is written for the beginning college student. The various factors included in milk production under current circumstances are most concisely discussed. The historical aspects of the dairy industry are omitted entirely. The author has taken the view that intelligent dairying requires the application of knowledge from a wide variety of areas. Two chapters on the physiology of milk secretion were prepared by C. W. Turner, and a chapter on the principles of soil management by R. S. Stauffer. Nevens has acknowledged the assistance of many well known colleagues in nutrition, physiology, genetics, veterinary science, agricultural engineering, and agricultural economics. As a result the sections dealing with feeding, breeding, milk secretion, housing, economics, and general management are authoritative and up to date.

FREDERICK N. ANDREWS

SECRETION OF MILK. *Fourth Edition.*

By Dwight Espe and Vearl R. Smith. Iowa State College Press, Ames. x + 291 pp. + 1 pl.; text ill. 1952.

While the appearance of this edition, revised largely by Vearl Smith, should be willingly received, it is only natural that some regret will be felt that its originator has seen fit to entrust his creation to younger hands. The aim of the book to meet primarily the needs of the student at the undergraduate level has been sustained during its considerable revision. Much of the revision is concerned with the more recent views on the hormonal interrelations in mammary gland development and lactation. The inclusion of a chapter on the Physiological and Biochemical Aspects of Lactation is commendable, and calls attention to the ever-increasing importance of such studies. Perhaps the merit of giving equal prominence to the mechanics of milking by raising it to the status of a chapter, however short, is questionable. In the chapter on the Physiology of Milking the increased interest in the phenomenon of milk ejection is reflected, the more so by including the recent studies of Richardson on the contractile tissue in the udder. The final chapter, Environmental Factors Affecting Lactation, deals with many miscellaneous factors which now appear in a more orderly arrangement. The authors are to be commended for accomplishing this fine revision without yielding to the temptation to expand the text. (See *Q.R.B.*, 25: 98. 1950).

JAMES I. RAESIDE

ANIMAL GROWTH AND DEVELOPMENT

ANTIBODIES AND EMBRYOS.

By F. W. Rogers Brambell, W. A. Hemmings, and M. Henderson. University of London, The Athlone Press. 12s. 6d. 103 pp.; ill. 1951.

In the Preface to this compact volume, the authors state that their aim is to give a coherent account of their own and related researches on the passage of antibodies from mother to foetus in rabbits. A complete review of the literature concerning the transmission of passive immunity from mother to young in mammals is not intended; only those works are cited which are necessary for an appreciation of the significance of the data presented. The outcome is a happy combination of scientific findings, presented in a clear and authoritative manner, and a critical evaluation of the pertinent literature. Following a concise account of reproduction in the rabbit, a section which provides the reader with the necessary background knowledge of the structure of embryonic membranes, the authors describe the series of ideas and experiments leading to their conclusion that in the rabbit, maternal antibodies reach the foetus by way of the uterine lumen and yolk sac, and not by way of the placenta. The account is complete and convincing. The authors properly emphasize that their studies have been confined to one species, and stress the dangers of assuming similarity of route of transmission in other species in which prenatal passage of immunity occurs. Since the fundamental problem involved is the mechanism of transmission of proteins across living membranes, the discussion should be of interest not only to embryologists and immunologists but to all students of physiology. Here is a wide field for research. A whole order of problems concerning the antigenicity of foetal proteins and the mediation of maternal response awaits elucidation. An excellent case in point is the finding that the selectivity of the yolk-sac splanchnopleure develops rapidly between the 20th and 24th days of development. At 20 days, bovine agglutinins are admitted to the rabbit foetal circulation nearly as freely as rabbit agglutinins. Thereafter, admission steadily decreases until at 24 days bovine agglutinins are almost completely excluded. This selectivity is a phenomenon of considerable interest, since it appears to be one of the few clear-cut instances in which a foetal tissue is capable of distinguishing between proteins of different specific origin. The book is complete with both author and subject indexes and has an excellent bibliography of pertinent papers. It is highly recommended.

JAMES D. EBERT

HUMAN EMBRYOLOGY. (*Prenatal Development of Form and Function*)

By W. J. Hamilton, J. D. Boyd, and H. W. Mossman. Williams & Wilkins Company, Baltimore. $9.00. viii + 432 pp.; ill. 1952.

In the second edition of this widely used and highly rated book on human embryology the entire text of 16 chapters has been extensively revised, and many of the chapters have been completely recast and rewritten. Some of the original figures in the first edition (see *Q.R.B.*, 21: 293. 1946) have been either redrawn or replaced and 69 new ones have been added, making a total of 433 excellent illustrations. Many of them are in color. Each chapter begins with a brief introductory statement to orient the reader, and to aid in rapidly locating special sections in the text there are boldface headings of subdivisions within the chapters as well as a valuable 21-page index covering all sections.

Following the first short chapter, which deals with the introductory concepts of embryology, there is a very well balanced account of the early formation and structure of the germ cells and the cyclic changes in the germinal tract related to the hormonal influences. Then the fertilization, segmentation, and early formation of the mammalian egg and embryo are presented, including the newly discovered beautiful two-cell human egg and the latest of human material now available. A valuable three-dimensional, as well as histological picture is clearly presented of the fertilized egg as it passes down the oviduct and into the uterus, where it is implanted and develops its extra-embryonic membranes in the endometrium.

A short chapter giving the over-all view of the fate of the germ layers is followed by a richly illustrated account of the growth and development of the external form of the embryo and foetus, with size and age up to birth recorded. A brief discussion is then given of the experimental and other factors controlling and modifying development in twinning and abnormal development. This is followed by chapters devoted to the development of the various organ systems, beautifully illustrated not only with photomicrographs at critical levels but with half-tone and colored drawings largely in model form, to give the important three-dimensional picture covering both the normal development and the more common anomalies found in man. The development of the skeletal, integumentary system and the muscles with fasciae are also treated in separate chapters.

There is a final valuable section on comparative vertebrate development, with many colored plates showing the chief similarities and differences in the early development of the various classes of vertebrates. The formation of the foetal membranes in the higher groups of vertebrates is briefly, but sufficiently, analyzed; and in a series of colored plates the successive stages of implantation and placental formation in various mammals are compared with that found in the human.

A valuable appended table lists the important early human embryos under 21 days of age, and gives their ages and dimensions, and the author, date, and reference to the publication describing them. Although the authors have attempted to keep the text as short as possible, they have succeeded in putting much of great value in it. The high quality and selection of the beautiful illustrations which accompany the clearly written text help make this the best textbook on human development yet prepared in the English language for medical students. No biological library is complete without a copy of this excellent book.

LEON STANSFIELD STONE

THE CHILD UNBORN.

By R. J. Harrison. The Macmillan Company, New York. $3.00. xiv + 226 pp.; ill. 1951.

Here is the whole story of human birth, as we know it today, set out for the "educated general reader." The author, a teacher of anatomy in the University of London, has a style so simple, direct, and clear that the special vocabulary of the science of reproduction is scarcely noticeable. Others have written more profoundly and philosophically about the individual phases of the process, but no one has placed the whole story within the covers of one book so clearly.

GEORGE W. CORNER, JR.

THE ADOLESCENT PERIOD: *A Pictorial Atlas. Monogr. Soc. Res. Child Develop., Vol. XIV, Serial No. 50, No. 2, 1949.*

By Frank K. Shuttleworth. Child Development Publications, Evanston. $1.50 (paper). 69 pp.; ill. 1951.

This monograph is devoted to lots and lots of pictures showing growth changes in boys and girls from 9 to 18. The author has assembled these photographs from various sources. He hopes that by graphic illustrations of different types of normal physical development teachers, parents, doctors, and even the adolescent himself will understand the wide variations that are possible in this age range, and so be reassured.

HELEN ARTHUR

PROBLEMS OF AGING. *Transactions of the Fourteenth Conference, September 7–8, 1951, St. Louis, Mo.*

Edited by Nathan W. Shock. Josiah Macy, Jr., Foundation, New York. $3.00. 138 pp. + 1 pl.; text ill. 1952.

The Fourteenth Conference on Problems of Aging, held in St. Louis in September, 1951, was devoted to 4 rather inclusive subjects: Biology and Medicine (John Esben Kirk); Sociology, Psychology, Education, and Religion (Robert J. Havighurst); Economics, Employment, and Welfare (Wilbur J. Cohen); and Medical Services, Hygiene, and Housing (J. W. Mountin). As in previous publications, the extensive discussion that broke into the prepared talks is rendered verbatim, so that all sorts of remarks on a bewildering variety of topics are hashed up in no order whatsoever. Cohen was able to keep the situation in hand, so that his chapter, discussion and all, constitutes a reasonably well-integrated presentation of the announced subject. The record of Mountin's talk is also fairly orderly; but the others were allowed to run into an assemblage of assorted bits of unrelated information. In the Preface, Fremont-Smith justifies this kind of publication on the grounds that it gives a picture "of what actually goes on in the minds of scientists." Maybe so—but who can afford to pay $3.00 for very little accessible information? and who, in the face of the flood of literature that every scientist must struggle against, has the time or patience to flounder through so much disorder in the hope of learning a little? The editor of the book, it appears, did not even consider its contents worth indexing.

FLORENCE MOOG

COWDRY'S PROBLEMS OF AGEING. *Biological and Medical Aspects. Third Edition.*

Edited by Albert I. Lansing. The Williams & Wilkins Company, Baltimore. $15.00. xxiii + 1061 pp.; ill. 1952.

The appearance, in 1939, of Cowdry's *Problems of Ageing*, was an event of importance in the history of biology and medicine. Although books on aging were not unknown at that time, Cowdry was the first to bring together the experiments and observations of a number of scientists having a special interest in some aspect of the problems of aging. That this factually-based volume filled a real need was attested by the demand that led to a 2nd edition after only 3 years. Now, a decade later, a 3rd edition has appeared. Under the editorship of A. I. Lansing, this new edition is really a new book.

The newness is apparent to the most cursory examination. The third edition has 40 chapters spreading over 1061 pages, as against 25 chapters on 758 pages, with fewer words per page, in the first edition. Of those 25 chapters, only 16 are now represented in something like their original form, and of these 7 are not the work of the original authors. A glance at the index shows the degree of difference sharply: under the "A's" almost every major item has changed except "adrenal,"

which has expanded, and "arteriosclerosis," which has not diminished. The spelling is more conservative, "ageing" being stubbornly retained, although somebody let the more generally accepted form, "aging," infiltrate the Table of Contents.

These alterations have the effect not only of bringing the book up to date in detail, but also of reflecting the change in emphasis and outlook that a decade of intense interest in old age has brought about. Whereas the first two editions were textbooks of gerontology, the third is more nearly a text in geriatrics. The interest in aging as a general phenomenon has given way to a practical, utilitarian approach. The earlier chapters on aging in plants and in various animals are gone, the material being reduced to a few passing references in Lansing's introductory chapter. Clark Wissler's fascinating essay on aging in various human cultures has been eliminated, and so has W. R. Miles' chapter on the psychological aspects of age. On the other hand, the latest edition contains numerous new chapters of specific interest to the practicing physician. Among these are Surgical Problems in the Aged (R. Elman), Anaesthesia in the Aged (E. Apogi), Rehabilitation for the Chronically Ill and Aged (H. Rusk and E. J. Taylor), Cosmetological Aspects of Ageing (M. Cheiffi), and a number of others.

Also new is a series of chapters on the social and economic problems of aging, which make up the third section of the book. Here the trend toward an older population, and the problem of providing useful employment beyond the conventional retirement age of 65, are dealt with in detail in chapters by P. M. Hauser and E. Shanas, and R. K. Burns and L. B. Brown. In chapters on the status of the elderly in American society, and on the personal adjustment of the aged, R. J. Havighurst and R. S. Cavan, respectively, report on statistical studies of the position and problems of older people. Both writers point to the importance of providing people passing middle age with suitable opportunities for employment, recreation, and social contacts.

The second section of the book is made up of 28 chapters under the heading, Clinical and Organic Problems of Ageing. The emphasis in this, the major part of the volume, is on the manifestations of aging in human beings, although individual chapters range from the almost purely clinical (W. P. Covell on The Ear) to the basically biological (F. Payne on cytological changes in the endocrine glands of aging fowls). Numerous other chapters deal with the respective organ systems, sometimes from several points of view. Thus J. R. Oliver writes on The Urinary System and N. W. Shock on Age Changes in Renal Function. As might be expected, problems of the heart and great vessels (P. D. White), arteriosclerosis (J. M. Steele), hypertension (W. S. Hartroft), and hematologic values (J. B. Shapleigh, S. Mayes, and C. V. Moore) are given more attention than in the earlier editions. The same is true of homeostatic mechanisms, treated in the new volume by Shock, and from the endocrinological point of view by E. W. Dempsey.

Of most interest to biologists is the first section of the book, entitled Biological and Cellular Problems of Ageing. This opens with a chapter on general physiology, in which A. I. Lansing deals largely with his own studies on aging in rotifers. Cowdry has rewritten his essay on aging of tissue fluids, and has contributed an important new chapter on aging of individual cells. Other papers in this section have been brought up to date by their original authors: Aging Processes Considered in Relation to Tissue Susceptibility (W. deB. MacNider), Quantitative Histochemical Changes in Ageing (O. H. Lowry and A. B. Hastings), and Chemical Aspects of Ageing and Effect of Diet (C. M. McCay). McCay's chapter remains among the most fascinating and challenging in the book.

An examination of the bibliographies in the first section supports Lansing's contention that "research on the biology of ageing is almost at a standstill." On the histochemical aspects of aging in post-mature animals, for example, Lowry and Hastings have been able to cite only 4 papers that have been published in the 10 years since the second edition of the book appeared. Yet the situation may not be as bad as the editor's pessimism makes it seem. Lansing rejects the view that aging begins at conception, regarding it rather as a matter of "generally progressive deleterious changes in adulthood." Certainly this limitation is not indefensible; yet those who wish to promote the science of gerontology must not lose sight of the fact that the attempt to understand the nature and etiology of "deleterious change" implies a thorough understanding of the normal mature state. Not every study that contributes to our knowledge of aging need deal with the aged.

If the biological aspects are at a standstill, the practical results of aging research are not rushing forward very fast either. L. I. Dublin summarizes his chapter, Longevity in Retrospect and Prospect, in the very same words he used in the 1939 edition. Nature has allotted man a life span of 100 years, Dublin tells us again, and if we keep on trying we may be able to push the average up to 75 years.

FLORENCE MOOG

ANIMAL MORPHOLOGY

VARIATION AND SELECTION IN THE CERVICAL CENTRAL ARTICULATIONS OF LIVING TURTLES. *Bull. Amer. Mus. Nat. Hist., Vol. 94, Art. 9.*

By Ernest Edward Williams. American Museum of Natural History, New York. 75 cents (paper). Pp. 505–562; ill. 1950.

Williams has examined cervical vertebrae from 1289

individuals, representing 12 of the 13 families and subfamilies of living turtles. In addition to analyzing the morphology, he also discusses the functional anatomy of these neck bones. There is a stimulating section on adaptation and selection which is written with a modern genetical approach. One of the interesting observations concerns the considerable variation occurring in some of the species, from which the author constructs structural series which he believes represent actual evolutionary stages responding to selection.

ARNOLD B. GROBMAN

A METHOD OF ANATOMY *Descriptive and Deductive. Fifth Edition.*

By J. C. Boileau Grant. Williams & Wilkins Company, Baltimore. $7.00. xxiv + 870 pp.; ill. 1952.

This fine textbook has again been improved and clarified. The number of figures has been increased to 862. Logical presentation with frequent references to the embryological backgrounds of adult structures makes "Grant" a book for the teacher and practitioner as well as for the undergraduate. The approach is regional and relations are heavily stressed. Frequently the outstanding points of the parts under discussion are brought together in excellent tabular summaries. The meaning of various anatomical details in terms of living anatomy is considered with each appropriate part or region. Altogether, the author's qualifying statement about the book seems fully justified. It is truly "descriptive and deductive."

JOHN A. CAMERON

INTRODUCTION TO DENTAL ANATOMY.

By James Henderson Scott and Norman Barrington Bray Symons. E. & S. Livingstone, Edinburgh and London; [Williams & Wilkins Company, Baltimore.] $7.00. viii + 292 pp.; ill. 1952.

This is a beautifully illustrated and well assembled book, good for the dentist and the dental student to own and to read. It cuts boldly across the usual boundaries of several departments and courses as they are usually found in American dental colleges.

The chapters include a treatment of development, dental histology, bone structure, structure and function as related to mastication, the detailed forms and relations of the individual teeth, dental development studied by means of x-rays, chronology of the dentition, evolution of the jaws and of the temporomandibular joint, and several chapters (nearly 100 pages) dealing with comparative dental anatomy and the form of teeth in relation to function. This is an interesting and cohesive book, despite its broad scope.

JOHN A. CAMERON

ORAL ANATOMY. *Second Edition.*

By Harry Sicher. The C. V. Mosby Company, St. Louis. $13.50. 529 pp.; ill. 1952.

This fine textbook has been enlarged and improved, 20 of the excellent illustrations being in color. The presentation is orderly, direct, and clear, with good integration of basic and clinical material. Part One, Descriptive Anatomy, covers the skull and its separate bones, the muscles of the head and neck, the temporomandibular articulation, the viscera of the head and neck, and the vascular and nervous structures of these regions.

Part Two, Regional and Applied Anatomy, has chapters on the palpability of the facial skeleton, the structure and relations of the alveolar processes, anatomy of local anaesthesia, arterial hemorrhages and ligation, the propagation of dental infections, tracheotomy and laryngotomy, the temporomandibular articulation, and the edentulous mouth. Structure and function are everywhere related and clarified, and the use of knowledge and information in the service of the patient is constantly stressed. Not only is this a valuable desk reference book for the dentist, but a book for habitual reading by those concerned with oral anatomy.

JOHN A. CAMERON

A TEXTBOOK OF HISTOLOGY. *Sixth Edition.*

By Alexander Maximow and William Bloom. W. B. Saunders Company, Philadelphia and London. $10.00. x + 616 pp.; ill. 1952.

The sixth edition of this standard textbook for medical students includes a new introductory chapter by W. L. Doyle, correlating, on a very elementary level, the chemical constitution of cells with their microscopic structure. P. P. H. DeBruyn has revised and shortened the chapters on blood, connective tissue, and the lymphatic system. I. Gersh has written new descriptions of the endocrine glands.

The number of illustrations has been greatly increased. There are a number of beautiful phase contrast photomicrographs, and admirable electron micrographs, as well as useful diagrams and semidiagramatic drawings, but in my opinion the free use of drawings in the classical manner, rather than photomicrographs, is to be deplored. A drawing is not scientific evidence, and may impede rather than promote the student's understanding of his sections.

EVELYN HOWARD

VISCERAL INNERVATION AND ITS RELATION TO PERSONALITY. *American Lecture Series Publication Number 115. A Monograph in American Lectures In Anatomy.*

By Albert Kuntz. Charles C Thomas, Springfield, Ill. $4.50. viii + 152 pp.; ill. 1951.

The intention of this book is to give a brief and simplified account of the anatomic basis of the innervation of visceral organs and of central neural mechanisms concerned with visceral functions; to point out important functional interrelationships of visceral and somatic nerves; and to illuminate the role of the viscera and neural impulses of visceral origin in emotional experience and expression, relating the latter to the total personality. The responses of the viscera to events occurring elsewhere in the body are discussed with particular reference to the effects of emotional stimulation. Somewhat more attention is given to non-visceral responses, particularly emotion-linked responses, to visceral dysfunction. Limited reference to the role of cerebral cortical areas is included.

In fulfilling the first two of the aims of the book, viz., the treatment of the anatomy of the autonomic nervous system and the functional interrelations of it with the central nervous system, the author is reasonably thorough. This part of the book would seem to be a condensation of an earlier, far more detailed work. The text is terse and concise and frequently difficult to read. Five chapters of the book are devoted to these first two aims: the first chapter is a general introductory discussion; the second deals with the autonomic nerves; the third with reflex and integrating centers and central conduction pathways concerned in visceral functions; the fourth treats the topic of the general physiology of the autonomic nervous system; and the fifth chapter is devoted to a discussion of the innervation of specific visceral organs. The sixth and final chapter is reserved for the topic of visceral neural factors in personality. In it the author seems reluctant to abandon the firmer facts of anatomy; consequently much of it is circumlocutory. A distinction is made between emotional experience and emotional expression and their corresponding mechanisms. Thenceforward most of the discussion centers around the mechanisms governing and influencing the expression of emotion, those involved in the expression of sham rage constituting the only example given. Although there is admittedly less known about the physiology and psychology of emotional experience than of emotional expression, there is a great deal more available on both than is represented here. Since, however, the author exhibits thorough familiarity with the anatomic data, less with the physiologic, and virtually none with the psychologic, the omissions are most likely traceable to the regrettably poor communication between scientific specialties.

O. THOMAS LAW

ESSAYS IN BIOLOGY. *Presented to Arthur Neville Burkitt. A Collection of Essays Written by Some of His Pupils to Celebrate His Completion of Twenty-one Years as Head of the Department of Anatomy, University of Sydney. Australasian Medical Publishing Company, Glebe, Australia.* Paper. 164 pp. + 4 pl.; text ill. 1948.

An interesting Festschrift of diverse contributions to the field of anatomy. Contents: Genetic Types in Teeth (A. C. Gabriel); The Neuro-Anatomy of the Visual System (Herbert J. Wilkinson); The Prosencephalization of Motor Control: A Preliminary Note (A. A. Abbie); Radiographic Studies of the Sella Turcica in Hypophyseal and Extrasellar Tumours (Gilbert Phillips); Electrophysiology in the Study of Neuroanatomy (A. K. McIntyre); Experimental Hydrocephalus: a Few Observations, Old and New (S. M. Morson); Suppressor Activity in the Human Brain (B. D. Wyke); Experimental Studies on the Reactions of the Spinal Cord to Injury, with Special Reference to Cavitation (B. G. Goswell); Experimental Studies on the Internal Vertebral Venous Plexus (W. F. Herlihy).

The volume deserves to be called to the attention of geneticists, neuroanatomists and neurophysiologists who might otherwise overlook it.

ANIMAL PHYSIOLOGY

PATTERNS OF ORGANIZATION IN THE CENTRAL NERVOUS SYSTEM. *Proceedings of the Association, December 15 and 16, 1950, New York. Research Publications Association for Research in Nervous and Mental Diseases. Vol. 30. Edited by Philip Bard. The Williams & Wilkins Company, Baltimore.* $12.00. xii + 581 pp.; ill. 1952.

This is another volume in one of the most important and interesting series available to those concerned with problems of the nervous system. In the past, it has been the custom for the Association to discuss one topic in all its aspects—anatomical, physiological, medical, surgical, etc. It is of great interest, therefore, to see that the entire 30th meeting was devoted to neurophysiology, and very successfully presented a number of recent developments in certain aspects of the field of nervous function.

The 25 papers presented have been divided into 4 groups: Section I—Concerned with studies of reflex patterns and their organization; Section II—Concerned with motor functions and descending pathways; Section III—Concerned with the cerebellum and its relationships to other central levels; and Section IV—Concerned with ascending systems and concepts of "higher" cerebral functions. Each section (but the second) is followed by a short summary—a new idea in these proceedings and one for which the editor is to be congratulated. It is further to be noted that "Several relevant fields of enquiry were purposely omitted from the program, either because they have been dis-

cussed recently elsewhere or because it was judged that they had not yet reached a stage of development appropriate for inclusion."

It is obvious that one cannot discuss, in a short review, the myriad problems and concepts presented in such a volume. Suffice it to say that no one interested in the functional aspects of the nervous system can afford to overlook these discussions. They are vital for students at all levels and in all fields concerned with nervous tissue, whether in physiology, clinical neurology, neurosurgery, psychology, or psychiatry. Psychiatrists may be interested to observe that despite the present trend in their field away from physiology and toward psychology, the Association for Research in Nervous and Mental Disease has thought it worth while to devote an entire meeting to the former.

ROBERT G. GRENELL

RENAL FUNCTION. *Transactions of the First Conference, October 1949, New York.*

Edited by Stanley E. Bradley, Josiah Macy, Jr. Foundation, New York. $2.50. 172 pp. 1950.

The conviction of the Josiah Macy, Jr. Foundation that one of the greatest needs today is a reintegration of science now artificially fragmented by the isolation of the various disciplines has in this instance led to an interesting record of the views of a group of kidney intelligentsia. "Within recent years there has developed an increasing interest in kidney function for in what other field of human physiology are we so directly and urgently faced with the ultimate question, of how an organ as a whole functions and how the individual cells perform their respective tasks?" The symposium was opened by Jean Oliver, a morphologist. F. Binkley reported on the characteristics of a renal glutaminase, which he proposes as a candidate for a part of the mechanism for certain major aspects of absorption by the kidney. This insoluble lipoprotein may behave as a self-regenerating ion exchange resin. J. V. Taggart contributed an inspiring analysis of renal metabolism by means of metabolic inhibitors applied to an isolated phosphorylase, isolated tubules, kidney slices, and intact animals. R. Berliner described tubular secretion of potassium. R. F. Pitts summed up a good deal of discussion by various doctors and saints when he concluded: "I am becoming convinced that I don't know anything about sodium. I have been working on it for several years and I know much less than I thought I did when I started." However, this conference seems to some extent to have succeeded in its director's difficult aim of recording in place of "the narrow mold" of logical sequence something of the seething multivalent enthusiasms of science.

EVELYN HOWARD

FUNCTIONAL ENDOCRINOLOGY *From Birth Through Adolescence.*

By Nathan B. Talbot, Edna H. Sobel, Janet W. McArthur, and John D. Crawford. Published for the Commonwealth Fund at the Harvard University Press, Cambridge. $10.00. xxxii + 638 pp.; ill. 1952.

"This book is written for practitioners, students and investigators of medicine and surgery who seek practical information concerning (a) the actions of endocrine systems in health and ordinary disease and (b) the management of endocrinopathies as they occur in young people." This ambitious project has been carried out by the authors with considerable success. The result is a well balanced, thoughtful exposition of the fundamentals of pediatric endocrinology. Considerations of functional dynamics of the endocrine glands alternate with practical advice on the management of endocrine disorders in childhood and adolescence. In order to make this "book as concise, clear and self-sufficient as possible," the authors had to sift their material. On the whole their choice of material is excellent. However, in view of the practical importance of determining the "bone age" in pediatric endocrinology, the omission of roentgenograms to illustrate skeletal maturation is to be regretted.

In some chapters a lack of clarity detracts from the enjoyment of reading. For instance, in discussing treatment with androgens, the authors at times fail to differentiate clearly between testosterone and methyltestosterone, as though these substances were identical. Nor can I find any advantage in substituting the term "pseudo-precocious puberty" for the well established and descriptive term "macrogenitosomia precox." The discussion of the mode of action of the various types of insulin is somewhat confusing. The authors express doses of drugs per square meter of body surface area. This may be correct from an academic point of view, but sentences like the following are not conducive to readability on the part of the practitioner who is seeking information on the management of endocrinopathies: "It now looks as if as little as 20 or 30 mg of cortisone per m^2 per day may suffice to abolish the excessive 17-ketosterioduria."

These minor criticisms are far outweighed by the excellent presentation of the main problems. Diagnostic and therapeutic considerations reveal the authors' great experience in studying and treating children. Many of the ideas and their presentation as diagrams reveal the profound influence of Fuller Albright. The book is beautifully illustrated, and the references are well selected. The index is excellent. The Harvard University Press has chosen a very pleasing format.

The book is to be warmly recommended not only to those for whom it is primarily intended, but also to biologists in general.

WALTER FLEICHMANN

GYNAECOLOGICAL ENDOCRINOLOGY *for the Practitioner. Second Edition.*

By P. M. F. Bishop. The Williams & Wilkins Company, Baltimore. $2.00. x + 132 pp. + 2 pl.; text ill. 1951.

Among the flood of volumes on the endocrinology of the menstrual cycle, this lucid little handbook by one of England's leading endocrinologists should be quite popular. Now in its second edition, it serves a larger audience than the author modestly claims for it, namely, the general practitioners and medical and postgraduate students in gynecology, for it will also appeal to gynecologists, biologists, and physiologists as well as those with a passing interest in endocrinological problems.

Gynecological endocrinology is a young and confused field in which hopes and theories have been far more prevalent than provable facts and practical results. It is refreshing to find someone conservative like Bishop, who cleaves to the proven and who warns against irrational and dangerous therapeutic programs and questions the worth of some time-honored regimens. One may differ with some of his pet programs, but then every endocrinologist has his hobby horses.

The chapter on steroid chemistry is a model of clarity, probably derived from a similar effort in a book by my own father. It should be of interest to all readers in pointing out the interrelations of the gynecologically active steroids. Finally, the therapeutic information in the Appendices should make the book a vade mecum for the busy clinician.

GEORGE W. CORNER, JR.

VERGLEICHENDE PHYSIOLOGIE. *Bd. 1. Sinnesphysiologie.*

By W. von Buddenbrock. Verlag Birkhäuser, Basel. Sw.fr. 41.60 (paper); Sw.fr. 45.75 (cloth). 504 pp.; ill. 1952.

The 3rd edition of this basic textbook covers the field of sensory physiology in a separate volume. Neurophysiology, previously combined with it, will be treated in a separate book. Coverage is broad and thorough. The topics range through the usual visual, mechanical, and chemical senses to those less frequently treated—vibration, humidity, and time senses, for example. The comparative physiology of color vision is particularly well treated, and frequent tabular summaries for much of the entire material make this a useful reference book. In addition, there are frequent stimulating suggestions which clearly point to important research problems in this general field. The book is well illustrated, but suffers from one important drawback. Studies quoted in the text are frequently not listed in the bibliographies which follow each section. In spite of this defect, this is a welcome book in an area where a comparable book in our own language is completely lacking.

The contents are as follows: Introduction to Sensory Physiology; Vision—General Laws, Movement Reactions to the Light Stimulus, Special Physiology of the Eye, Color Vision, and Visual Substances; Mechanical Senses—Touch, Proprioception, Static Sense, Audition, Vibration and Temperature Sense; Chemical Senses—Odor, Taste, Chemical Senses in Lower Organisms, Humidity Sense, Pain, and the Time Sense.

ECKHARD H. HESS

RECENT ADVANCES IN THE PHYSIOLOGY OF VISION.

By Hamilton Hartridge. The Blakiston Company, Philadelphia. $5.00. xii + 401 pp.; ill. 1950.

New developments in visual science have been so rapid during the past two decades that it is almost impossible for the general reader to keep abreast of them. For this reason, Hartridge's book is a welcome addition to the growing literature in the field. In it, he has summarized the contributions of about 150 of the most significant papers and books to appear during the last 20 years. They are grouped into 8 chapters headed Some Basic Properties of Vision, The Perception of Shape and Size, Investigations of Retinal Function, The Perception of Colour, Some Theories of Vision, The Neurology of Vision, Some Properties of the Structures of the Eye, and The Appreciation of Light and Colour.

Despite its wide coverage of the recent literature, Hartridge's book successfully manages to avoid the appearance of an annotated bibliography. Although primarily concerned with new advances, the author has also discussed many older and classical studies as a way of integrating the recent work into the growing mass of visual literature and as a way of evaluating the importance of the newer contributions. In addition, Hartridge repeatedly points to gaps in our present information, and suggests directions in which future research might usefully be oriented. This great amount of supplementary material has produced a book so well rounded that it could easily serve as a textbook. One thing is certain: the general reader and specialist alike are sure to find many stimulating ideas and facts in it.

A. CHAPANIS

THE MEASUREMENT OF HEARING.

By Ira J. Hirsch. McGraw-Hill Book Company, New York, Toronto, and London. $6.00. ix + 364 pp. ill. 1952.

Too often the techniques used and developed by clinical practitioners have remained aloof, or at least remote,

from the experimental science which treats of the same problems. The clinician is not aware of the experimental material, and the scientist exhibits little concern for the practical problems of the clinician. This book represents an excellent example of how the two should and can be brought together. The book is concerned with the measurement of hearing—the techniques, basic experimental information, advantages of some techniques over others for particular clinical purposes, etc. It is a novel experience to read a book which is obviously oriented toward clinical problems but is equally obviously using experimental material as a take-off point. The author has, however, succeeded in preventing the reader from becoming too uncomfortable as he goes through this new experience.

The first 3 chapters provide purely background material. The first chapter discusses some of the basic psychological problems involved in the measurement of sensation. The second chapter discusses the physical and electrical nature of the sound system, while the third chapter describes in moderate detail different electroacoustic systems. These chapters should give the reader a fair background to understand the experimental and clinical tools used in the measurement of hearing.

The next 6 chapters discuss the measurement of different kinds of auditory experience. Chapter 4 is a good summary of available information about absolute thresholds. The next chapter discusses the measurement of speech intelligibility, and includes a good short section on the nature of speech sounds, and a discussion on the use of speech tests in clinical measurement. Chapter 6 is concerned with auditory masking and fatigue, and is an excellent summary of these closely related topics. Chapter 7 takes care of differential sensitivity, and Chapter 8 does the same for loudness and recruitment. The latter chapter is somewhat more important for the clinician because of the increasing use of loudness relations in the diagnosis of hearing impairment. Chapter 9 discusses problems of binaural hearing, and provides a good section on bone conduction as a special case of binaural hearing.

The tenth chapter describes some of the more recently developed conditioning techniques now being used in clinical testing, and as background for these techniques presents some of the basic psychological information on conditioning. This chapter should probably be required reading for any clinician using such techniques. It will clarify his thinking considerably. The last chapter summarizes much of the material previously presented on the clinical techniques.

There are two appendixes which should be very useful to otologists and audiologists. The first of them provides AMA specifications for commercial audiometers. The other provides lists of speech material which can be used in clinical testing. In addition, there is a fairly complete glossary of technical terms.

The author has written this book as a psychologist writing to those engaged in the measurement of hearing disorders. His primary intent was to provide a reference book for otologists and audiologists—the two professional groups primarily concerned with the clinical measurement of hearing—and a textbook for students aspiring to one or the other of these professions. The author has been eminently successful in accomplishing this primary intent, an intent which is clear in almost every chapter of the book. For example, the general pattern followed in each chapter is to start with a brief statement of the importance of the topic to clinical audiometry, then to present the pertinent psychophysical data, and to end with a section on clinical applications of the pertinent data. This clear-cut goal has provided a coherence to the book which is not often found.

The same coherence which is such an advantage for one audience, is almost of necessity a disadvantage for other audiences. The book has been very successful in presenting information about the psychological aspect of problems to the clinician; it has not been equally successful in presenting clinical aspects of the problem to psychologists. For example, there is at no point a discussion of the different kinds of deafness. It is assumed that the clinician knows why he wants to test hearing, and what kinds of decisions he might make. Furthermore, the psychological material is probably of equal difficulty to the clinician, but it is of very uneven difficulty to the psychologist. No material is included on the anatomy and physiology of the ear. In addition, the material is not presented in any attempt to provide an exhaustive treatment of the subject. The bibliography cannot be used as definitive.

These statements are not intended to be criticisms of the book. The author had his own goal and he has achieved it. The comments are presented, rather, to define the areas of other application. Parts of the book would make good auxiliary reading for courses in sensation and perception, or as assignments to psychologists or biologists beginning to be interested in hearing. The introductory chapters certainly would be useful reading to non-psychologists interested in hearing, and except for the first chapter, to psychologists as well. The book's chief value, however, will undoubtedly be for clinicians. They probably cannot find a better treatment of the experimental basis of their audiometric procedures.

W. R. GARNER

BIOPHYSICS

SYMPOSIUM ON RADIOBIOLOGY—THE BASIC ASPECTS OF RADIATION EFFECTS ON LIVING SYSTEMS. *Oberlin College, June 14–18, 1950. Sponsored by The National Research Council of the National Academy of Sciences. Edited by James J. Nickson. John Wiley & Sons,*

New York; Chapman & Hall, London. $7.50. xii + 465 pp.; ill. 1952.

The Oberlin Conference on Radiobiology, the results of which are embodied in the present group of essays, holds a particular interest since it purposely deals with the basic effects of radiation on living cells, and thus departs from the many previous radiobiological volumes which have, in the main, treated topics of narrower and more specialized scope. The general biologist will find much in the volume of value to him, since it will provide an intelligible account of an exceedingly complex area of research at the same time that it will give him an appreciation of the importance of radiological work to the whole field of biology. Such is highly desirable because of the relatively large amounts of public money which are being poured into these studies, often to the exclusion of other biological disciplines.

The symposium, and the present volume, can be looked upon as dealing with 4 aspects of radiobiological interest, namely, the physical, chemical, biochemical, and organismal, with the visible cellular effects included under the latter. In each essay there has been a conscious attempt to present, in as simple a form as possible, the concepts and ideas prevailing in the field. and to hold to a minimum particular sets of data which, however interesting in and of themselves, have not yet been incorporated with certainty into the general picture. The result is a thoroughly readable volume containing the broad bases upon which critical evaluation of the biological effects must rest. Some of the essays are inevitably more highly technical than others, but a high degree of readability has been achieved without sacrifice of content or of discriminating points of view. To what extent this reflects the guiding hand of the editor and his aides it is not possible to determine, if it were desirable. One can only commend.

It is not feasible here to present in detail the contents of each essay. The first 4 deal with the pure physics of radiation, while the next 5 are largely concerned with the chemical picture. Each is handled by an authority in the field, and the reader will be pleased to find that the usual symbolism of the physicist and chemist is replaced by well-worded statements that are relatively easy to follow and to appreciate. Four chapters are concerned with the biochemical effects of radiation, and some semblance of intelligibility emerges from this tangled field even though translation of the biochemical effects into terms of grosser manifestation at the cellular level remains to the future. Hiatuses in our knowledge are clearly indicated and acknowledged, and the prospects of relating biochemical change with cellular upset or alteration seem appreciably brighter. This seems particularly true as more information is gained regarding the role of active radicals in radiation damage, and regarding the role of protective agents in offsetting or interrupting the chain of events which lead to damage or to death of cell or organism.

The remaining 10 chapters deal, more or less, with biological effects, but the essayists appear to be fully aware of the extensive physical and chemical background upon which they can draw. That this cannot always be done with profit is obvious, but the evident rapport between the various disciplines is encouraging. A feeling of mutual dependence and interest was evident at the symposium, and is also evident in this volume, and the various essays reflect the feeling that each investigator, regardless of his particular interest in radiobiology, must have an appreciation of the problems and techniques of the other fellow if he is to apply his own data and concepts to problems beyond his immediate sphere of operation.

This is therefore an excellent volume, not alone because of the material covered but also for the gaps which are made apparent. The discussions appended to each chapter form an important part of the book. There is, however, one serious fault; the book lacks an index of any sort. To the worker in the field of radiobiology this may not be too serious, since he will in general be acquainted with the area in which each contributor works. The outsider, on the other hand, will be unable to turn at will to any particular topic (and various aspects of one topic may be scattered through several chapters) except as he can judge from the titles of chapters. In a volume so important it would seem that the inclusion of a subject index, or at least an author index, would be indispensable. That such is missing detracts appreciably from the usefulness of the book to anyone not thoroughly familiar with the entire field of radiobiology. Few are so broadly trained.

C. P. SWANSON

BIOCHEMISTRY

FORTSCHRITTE DER CHEMIE ORGANISCHER NATURSTOFFE. *Volume Eight.*

Edited by L. Zechmeister. Authors: Y. Asahina, R. B. Corey, A. Frey-Wyssling, F. Galinovsky, G. W. Kenner, L. F. Leloir, K. Mühlethaler, M. Pailer, C. R. Ricketts, M. Rohdewald, H. Schinz, M. Stacey and L. Zechmeister. Springer-Verlag, Wien. DM. 67.—; $16.00 (paper); DM. 70.50; $16.80 (cloth). xi + 400 pp.; ill. 1951.

This volume, like its predecessors (*Q.R.B.*, 27: 117, 1952) contains a wealth of valuable material. The subjects treated include the texture of cellulose fibers (Frey-Wyssling and Mühlethaler), the preparation and properties of bacterial dextran, an important blood substitute (Stacey and Ricketts), the chemistry of sugar phosphates (Leloir), and the isolation, structure, and synthesis of nucleosides and nucleotides (Kenner). Biochemists will be particularly grateful to R. B. Corey for his contribution in which the evaluation of x-ray diagrams of amino acids and peptides is explained, and

their translation into structural formulas is made understandable. Other contributions deal with the odoriferous substances of violets (Schinz), the lichenic acids and depsides (Asahina), the alkaloids of lupines (Galinovsky), and those of the ipecacuanha root (Pailer). It is gratifying for biologists that in each of these articles an attempt is made to explain the biosynthesis of the complicated molecular structures, and that many of these structures have been produced, recently, in the laboratory under almost physiological conditions, i.e., at low temperature, in aqueous solutions, in some cases near neutrality. The volume is closed by an article of the editor, L. Zechmeister, on the separation of enzymes by chromatography. The long lists of references accompanying each of the articles make this volume indispensable to investigators interested in the chemistry of natural products.

FELIX HAUROWITZ

THE ENZYMES. *Chemistry and Mechanism of Action. In Two Volumes (Four Parts).*

Edited by James B. Sumner and Karl Myrbäck. Academic Press, New York.

Vol. I, Part 1: $13.50. xviii + 724 pp.; ill. 1950.
Vol. I, Part 2: $12.80. x + Pp. 725–1361; ill. 1951.
Vol. II, Part 1: $14.80. xii + 790 pp.; ill. 1951.
Vol. II, Part 2: $14.00. xi + Pp. 791–1440; ill. 1952.

These volumes represent an attempt to compile in comprehensive form the findings of the various phases of enzymology. The aim of the editors and publishers has been to present systematically the accumulated knowledge in the different aspects of enzymology, as well as related fields, in the form of a comprehensive survey so as to serve those already working in the field as well as those preparing to enter it. Accordingly, about 80 biochemists from different parts of the world, each an authority on certain aspects of the field, have contributed the chapters which go to make up these volumes. Apparently the authors have not been required to adhere to any particular style or format in the organization and presentation of their material; nor have they been rigidly restricted in the coverage of their topics, since some inevitable overlapping occurs.

In Part I of Volume I, 8 of the 19 chapters are devoted to the more fundamental aspects and general chemistry of enzymatic reactions. The first article, entitled Introduction, is written by the editors themselves and is concerned with the more general features of enzymology, its early history, terminology and classification, general properties, and determination of enzyme activity.

E. A. Moelwyn-Hughes, in his discussion of Physical Chemistry and Chemical Kinetics of Enzymes, includes such topics as the determination of molecular weights of enzymes, electrophoresis, and structure and stability. The chapter Enzyme Specificity, by B. Helferich, covers various examples of specificity as well as resulting inferences about enzyme structure. M. G. Sevag, J. S. Gots, and E. Steers have contributed an extensive chapter on the Enzymes in Relation to Genes, Viruses, Hormones, Vitamins and Chemotherapeutic Drug Action. Various observations indicating the control by genes of abnormal enzymatic activities, such as the formation of abnormal products, pigmentation, and growth-factor-requiring mutants are presented. Enzyme activities of free virus particles and the activity of virus-infected cells and normal host cells are compared. The relationship of such hormones as insulin, thyroxin, steroid hormones, growth hormones, and epinephrine to specific enzymes as well as to different metabolic processes, plus a detailed discussion of the action of chemotherapeutic agents on enzymes, are topics also included.

The chapter Cytochemical Foundations of Enzyme Chemistry (A. L. Dounce) covers the enzymatic activities of the various cell components, including both cytoplasm and nucleus, with emphasis on the physicochemical techniques used in separations of the various cell units. Histochemical and microdissection procedures are also considered in some detail. S. Spiegelman's discussion of Modern Aspects of Enzymatic Adaptation represents a very stimulating and informative treatment of this very basic aspect of enzyme formation and transformation within the living organism. The chapter on Enzyme Inhibition, by L. Massart, deals with the phenomena of various types of inhibition, specific and non-specific, competitive and non-competitive. This includes a rich compilation of examples of the above kinds of inhibition with an extensive list of references, exceeding more than 200 citations. The review Enzymes and Immunology, by J. R. Marrack, describes the various reactions between antibodies and antigens and includes an examination of the specific combination of antigen and antibody with relation to composition and structure, as well as a discussion of enzymes as antigens.

The properties of several enzyme systems, all of a hydrolytic nature, are then considered in the remaining 11 chapters of the book. They include the article by R. Ammon and M. Maarma entitled Enzymes Hydrolyzing Fats and Esters which covers the systems of lipases, esterases proper, acetyl esterase, tropin esterases, cholesterol esterase, chlorophyllase, and tannase; Acetylcholine Esterase and Cholineesterase (Klas-Bertil Augustinsson); Phosphatases (Jean Roche); Metaphosphate and its Enzymatic Breakdown (B. Ingelman); Sulfatases (C. Fromageot); Invertase (C. Neuberg and I. Mandl); α-D-Glucosidases (A. Gottschalk); β-Glucosidase, and Hydrolysis of Galactosides, Mannosides and Thioglycosides (both by S. Veibel); β-Glucuronidase (W. H. Fishman); and finally, to close this group of enzymes involved in the hydrolysis of sugars

and its derivatives, Amylases and the Hydrolysis of Starch and Glycogen (K. Myrbäck and G. Neumüller).

The Second Part of Volume I of *The Enzymes* is a continuation of extensive and informative articles, at the same high level, by various experts on enzyme systems. Further hydrolytic enzymes of carbohydrates are considered in the earlier chapters of this book and are followed by reviews of a variety of other systems, adding up to 24 chapters. Cellulases, Hemicellulases, and Related Pigments (W. Pigman), Pectic Enzymes (Z. I. Kertesz), and Enzymatic Hydrolysis of Mucopolysaccharides (W. H. Fishman) comprehensively treat the fields dealing with the enzymatic breakdown of complex carbohydrates, including the action of lichenases and enzymes attacking xylans, mannans, mannogalactans, wood, and gums; hyaluronidase, sulfomucase, chitinase, and heparinase. The economic and pathological significance of many of the above enzymes is also discussed.

The very valuable chapter on Proteolytic Enzymes, by E. L. Smith, is a high ranking, up-to-date account of this important field in enzymology. The various peptidases are classified, described, and characterized, with such phases as substrate specificity, inhibitions, and metal activation receiving due emphasis.

Urease (J. B. Sumner), Arginase (D. M. Greenberg), and Hydrolysis of Acid Amides and Amino Acid Amides (C. A. Zittle) are the next 3 articles. They consider the properties of the above enzymes as well as asparaginase and glutaminase, and include some details and references to preparative methods, activation and inactivation reactions, and other characteristics.

Two articles are by M. Laskowski: Allantoinase and Allantoicase, and Nucleolytic Enzymes. In the former the preparation, properties, and occurrence of the enzymes named are briefly discussed. In the second article ribonuclease, desoxyribonuclease, nucleophosphatases, nucleosideases, and nucleodeaminases are treated in the same manner.

One of the most outstanding chapters is on Phosphorylases—Phosphorolysis and Synthesis of Saccharides, by W. Z. Hassid, M. Doudoroff, and H. A. Barker. It deals with the formation and breakdown of glycogen and starch through the phosphorolytic process, polysaccharide phosphorylases, the synthesis of disaccharides with sucrose phosphorylase from *Pseudomonas saccharophila*, and the phosphorolysis of nucleosides.

The treatment of Transaminases by P. P. Cohen is fairly extensive, covering many aspects of this enzyme group and including such topics as analytical methods, preparation, substrate specificity, inhibition, mechanism of enzymatic transfer of the amino group, kinetics and thermodynamics, distribution in various organisms, and role in biological systems such as amine acid synthesis, peptide bond synthesis, and urea synthesis.

The other chapters of the book are on Hippuricase (Histoenzyme) and Histidase and Urocanase, by F. Leuthardt; 2 excellent reviews on protein coagulation, Enzymes and Coagulation. I. Milk Coagulation, by N. J. Berridge, and Blood Coagulation, by W. H. Seegers; Thiaminase, by R. S. Harris; Penicillinase, by E. P. Abraham; Transmethylases, by T. L. Sourkes; Enzymes as Essential Components of Bacterial and Animal Toxins, by E. A. Zeller; Enolase, by Otto Meyerhoff; Fumarase and Aconitase, by S. Ochoa; Desulfhydrases, by C. Fromageot; Aspartase, by J. Erkama; and Carbonic Anhydrase, by F. J. W. Roughton and A. M. Clark.

Part I, Volume II is devoted for the most part to a collection of reviews dealing with hydrogen-transfer systems. In addition there are chapters on phosphorylation, decarboxylation, enzymes in luminescence, and anaerobic respiration.

The first chapter, Theory of Oxidation-Reduction, by Leonor Michaelis, sets a high standard that prognosticates the excellence of the reviews which follow. This, the last contribution of Michaelis, is a lucid and stimulating discussion of the subject.

In Thermodynamics and Mechanism of the Phosphate Bond, Nathan O. Kaplan very capably reviews the important thermodynamic data and general properties of the phosphate cycle and presents some new and interesting calculations, some of which have since been experimentally verified. Sidney P. Colowick, in Transphosphorylating Enzymes of Fermentation, then surveys in a simple and clear style the transphosphorylation enzymes and compares intermolecular and intramolecular phosphate transfer. These 2 reviews are followed by the equally excellent chapter, Dephosphorylation of Adenosine Polyphosphates, by H. M. Kalckar. It deals with the various ATPases.

Aldolase and Isomerase, by Otto Meyerhoff, relates the history, preparation, properties, and thermodynamics of these enzymes. The contribution represents one of the final papers of the author before his death.

The decarboxylases are discussed in 2 reviews, Keto Acid Decarboxylases, by B. Vennesland; and Amino Acid Decarboxylases, by O. Schales. In the former the decarboxylases are classified into 3 groups, the α-ketocarboxylases, which are subdivided into the non-oxidative and oxidative classes; the carboligases; and the β-ketocarboxylases. In Schales' chapter the occurrence and properties of the various amino acid carboxylases, as well as their use for analytical purposes, are presented.

Desulfinase, by C. Fromageot, very briefly describes this enzyme; and a later chapter, Oxidation of Organic Sulfur, by the same author deals with the fate of various forms of sulfur in living organisms.

F. Schlenk has written two chapters, Codehydrogenases I and II and Apoenzymes, and Succinic Dehydrogenase. These present a historical and detailed survey of these systems. There is a rather brief review by W. W. Umbreit on Hydrogenase and Hydrogenylase.

The flavin enzyme systems are covered by Hugo Theorell in Flavin Containing Enzymes, by H. A. Krebs in Oxidation of Amino Acids, and by E. A. Zeller in Oxidation of Amines.

The iron-containing enzymes are treated in 3 chapters: Cytochromes, by K.-G. Paul; Catalases and Peroxidases—Hydroperoxidases, an outstanding review by Hugo Theorell; and a very stimulating article by Britton Chance, entitled The Enzyme-Substrate Compounds and Mechanism of Action of the Hydroperoxidases. There follows a paper on Copper Oxidases, by C. R. Dawson and W. B. Tarpley.

R. T. Holman and S. Bergström write on Lipoxidase or Unsaturated-Fat Oxidase, and E. Newton Harvey on Enzymes in Luminescence. This book closes with two general reviews: Anaerobic Glycolysis, Respiration, and the Pasteur Effect, by F. Dickens; and Yeast and Mold Fermentations, by F. F. Nord and S. Weiss.

Part 2, Volume II of *The Enzymes* is the last of the 4 books, and is devoted for the most part to discussions of various over-all processes and multistep conversions by biological systems.

The book opens with a chapter on Bacterial Fermentation, by S. R. Elsden, an outstanding review of the fermentation of carbohydrates and nitrogenous compounds. This is followed by a consideration of Enzymes in Detoxification, by F. Bernheim. He deals with the different preparations such as oxidases, esterases, acylases, and miscellaneous enzymes which metabolize certain drugs in vitro and which may or may not do so in vivo. This article brings together a number of very interesting enzymatic reactions, some of which may in time prove to be of far greater metabolic significance than now meets the eye.

In Urea Synthesis, H. A. Krebs describes the reactions by which urea is synthesized from ammonium ions in animal tissues, and evaluates the experimental evidence which bears on the individual steps of this process. Peptide Bond Synthesis, and enzymatic synthesis of Glutamine, both by P. P. Cohen, discuss the formation of peptide bonds, including those of glutathione. A number of model systems leading to net synthesis of peptide bonds as distinguished from peptide bond turnover is described. These articles are in turn followed by reviews on the Synthesis of Acetylcholine Choline Acetylase, by K.-B. Augustinsson, and on Oxidative Assimilation by Microorganisms, by C. E. Clifton.

An excellent chapter by S. Ochoa on Enzymatic Mechanisms of Carbon Dioxide Fixation describes the various systems forming carbon-to-carbon bonds by means of carbon dioxide fixation.

The problem of fatty acid synthesis from carbohydrates is presented in the stimulating review, Carbohydrate-Fat Conversion, by F. L. Breusch.

W. E. Loomis handles Photosynthesis in Green Plants in only 20 pages. He covers such topics as the photosynthetic equation, limiting factors, dark reactions, intermediate reactions, and the evolution of the photosynthetic process. The lucid and provocative chapter by C. B. Van Niel on Bacterial Photosynthesis completes coverage of the subject of photosynthesis with due emphasis on its broad comparative biochemical aspects.

Nitrogen Assimilation, by A. I. Virtanen and N. Rautanen, supplies an attempt to bring together the pertinent knowledge on the assimilation of molecular nitrogen and inorganic nitrogen compounds. It is a difficult task to cull the important material from the vast field of nitrogen assimilation literature without omitting some significant findings.

Tumor Enzymology, by J. P. Greenstein and A. Meister, summarizes the enzyme patterns of tumor tissue as well as of the tumor-bearing host.

The remainder of the book is devoted to a very long chapter, perhaps unduly so, upon Enzyme Technology. It is written by A. F. Langlykke, C. V. Smythe, and D. Perlman. Their article handles such topics as industrial fermentations, with the attendant operations problems, enzyme manufacture, and production of various substances such as alcohols, acids, vitamins and antibiotics.

These four books of the two volumes which constitute *The Enzymes* represent the most extensive and modern compilation of comprehensive reviews in the field of enzymology made to date. Together with the general excellence of quality and coverage, these features serve to make the volumes a very useful tool for the student as well as the experienced research worker.

Any criticisms one might make would be quite minor in contrast to their overwhelmingly positive values. In my opinion, however, an important topic has been omitted which rightfully belongs in a collection of this sort. There is a definite need for a chapter to summarize and integrate the role of metallic ions in enzyme systems. One or two outstanding articles of this sort have appeared within the last 2 years in the review literature. Another criticism of a minor nature is the failure in a number of instances to present a more logical sequence or grouping of related articles.

Practical methods in enzymology have necessarily received very little emphasis in these volumes. Only a small number of the articles have included descriptions of enzymological procedures, apparently to aid in a better understanding of the subject. There is still a very definite need for an up-to-date compilation of methods in enzymology to complement the above volumes.

ALVIN NASON

CARBOHYDRATE METABOLISM. *Correlation of Physiological, Biochemical and Clinical Aspects. Revised Edition.*

By Samuel Soskin and Rachmiel Levine. The University of Chicago Press. Chicago. $8.50. x + 346 pp.; ill. 1952.

The first edition of this popular book appeared in 1946 (*Q.R.B.*, 21: 393. 1946). This edition is enlarged to contain a description of advances in tissue enzyme chemistry and new information on the subject of carbohydrate metabolism. Major additions have been made in the chapters on alloxan diabetes and the activity of the pancreas. Discussions of hormonal regulation of metabolism have been amplified, e.g., in regard to the adrenal cortical steroids and insulin. A new summary has been added concerned with the results obtained from animal experiments and the study of metabolic diseases of man. The chapter on present frontiers of research in metabolism is most stimulating. There is scarcely any field in the biological sciences where the discussions on carbohydrate metabolism as presented in this book would not be useful from the viewpoint of research or study.

C. JELLEFF CARR

BIOCHEMISTRY AND PHYSIOLOGY OF PROTOZOA. *Vol. I. Edited by André Lwoff. Academic Press, New York.* $8.80. x + 434 pp.; ill. 1951.

A monograph such as the *Biochemistry and Physiology of Protozoa* has been long awaited by protozoologists. It serves to correlate the most prominent advances in recent years and will, no doubt, demonstrate to the biochemists that the protista are interesting and valuable tools for research.

At the beginning of their chapter on the Phytoflagellates, S. H. Hutner and L. Provasoli have quoted a proverb by James Thurber which states, "It is better to ask some of the questions rather than to know all the answers." This is the attitude with which most of the chapters have been written. The embryonic field of protozoan physiology has many unsolved problems which form gaping holes in any treatise on the metabolism and nutrition of protista. These holes have been plugged by inserting thought-provoking questions and speculations. However, the authors have been careful enough not to confuse speculation with fact.

The contributors to this monograph are André Lwoff (editor), Virginia C. Dewey, S. H. Hutner, George W. Kidder, Margueritte Lwoff, Ralph W. McKee, Luigi Provasoli, and Theodor von Brand.

A. Lwoff has written the introductory chapter, which discusses in broad terms general principles such as acellularity versus cellularity, nutrition, and biochemical evolution.

The chapter on the Phytoflagellates, by Hutner and Provasoli, includes a discussion of the evolutionary aspects of photosynthesis, the metabolic pool, growth of photosynthetic forms in the dark, induced apochlorosis, growth factors, and inorganic nutrition. Although the work of Moewus is passingly mentioned in this chapter, it is surprising that not one reference to his papers is given, particularly in view of the large number of papers which bear on subjects the authors discuss that has become available since the last war. Rather than allow work of such important consequences to "rest in limbo," it might be more profitable scientifically to present it to a larger audience for their evaluation. Perhaps future volumes will do this.

Chapter 3, by M. Lwoff, deals with the nutrition of the parasitic flagellates, the Trypanosomidae and Trichomonadinae. A detailed discussion on the trichomonads, including their nitrogen and carbon metabolism, media for isolation, and growth factors, is presented. Lwoff has treated only the growth factors of the Trypanosomidae here.

Von Brand continues the discussion of the Trypanosomidae in his chapter and enlarges on their metabolism. He has included an interesting section on the pathological physiology of infections with trypanosomes. Little is said concerning the Bodonidae.

M. Lwoff has written Chapter 5, on the Nutrition of Parasitic Amebae. The discussion is confined to the organism *Endamoeba histolytica*. This organism has not been sufficiently investigated because of inability to culture it on a synthetic medium. Lwoff has indicated that success should be achieved soon.

Chapter 6, by McKee, on the biochemistry of Plasmodium, adequately correlates the chemistry and metabolic constituents of the environment (blood) with the metabolism of malarial parasites. His discussion of the cultivation of malarial parasites is enlightening and interesting.

The final chapter, Biochemistry of Ciliates in Pure Culture, by Kidder and Dewey, is a rather complete presentation of inorganic requirements, carbohydrate metabolism, nitrogen metabolism, and growth factors. Most of the information stems from their research on *Tetrahymena geleii*. An adequate comparison with the metabolism of other ciliates is not possible due to lack of information.

This book is not suitable for a beginning student. It is an invaluable aid for anyone engaged in protozoan research. The book has also been found most satisfactory for a graduate seminar where a discussion of basic biological principles is desired.

ROLAND M. NARDONE
M. LEVINE

MICROSCOPIC HISTOCHEMISTRY. *Principles and Practice.*

By George Gomori. The University of Chicago Press, Chicago. $6.00. vi + 273 pp.; ill. 1952.

Both qualitative and quantitative methods are avail-

able for studies involving histochemistry. The latter have been summarized by Glick, who largely neglected descriptive methods. Now at last we have a book by Gomori dealing exclusively with morphological and qualitative methods. The two books complement each other very well. A criticism which can be levelled at both books is the almost complete separation of the descriptions of the methods from a consideration of the results and concepts derived through the application of the procedures. The strict separation of methods and results makes for dull reading and is to a certain extent misleading. For a method is really only as good as the results which arise from its use. And, after all, any given method in histochemistry, as in biochemistry, has its limitations and can be applied as given only to a limited number of materials. With the publication of these two books—one dealing predominantly with the qualitative and the other chiefly with the quantitative methods—it would now seem that we can hope that one or two qualified workers in the field may write a unified treatise on technique in histochemistry in which the impact of quantitative results on morphological studies and attempts at localization on microchemical analyses of tissues will be adequately assayed.

The book is divided into several sections: general considerations (about 30 pages), a specific consideration of methods for inorganic and organic substances (about 20 and 85 pages respectively), with special attention to enzymes (about 85 additional pages). This seemingly unbalanced attention to the enzymes reflects understandably the sustained and pioneering research interests of the author in this subject. The principles involved are discussed first, and are followed by the detailed procedures. Critical analyses of the various methods in the literature abound. The bibliography is most unusual in its completeness and appositeness, and will prove to be a most useful part of the book. At the end of the book there is an extensive list (about 25 pages) of Additional References, organized by subject matter. Here in particular the value of the references would be enhanced by the addition of titles.

The book is highly recommended, and for the time being fills a real need. It makes available methods, modifications, and discussions which are so widely scattered in the literature as to be largely inaccessible to most workers in other fields.

ISIDORE GERSH

THE CHEMISTRY AND PHYSIOLOGY OF THE NUCLEUS. *Experimental Cell Research, Supplement II. Proceedings of the Symposium held August, 1951 by the Biology Department, Brookhaven National Laboratory.*

Chairman and Editor, V. T. Bowen. Academic Press, New York. $7.00. xx + 402 pp.; ill. 1952.

In 1941, speaking at the University of Pennsylvania centennial celebration, Churney made the observation that to the physiologist the nucleus was a rather barren thing to be working with. At that time the study of the nucleic acids and proteins of the nucleus had only just begun to pay dividends, cytospectrophotometry was in its infancy, enzymes had not been found in the nucleus, chemical mutagenesis remained to be discovered, and the techniques for isolating nuclei and chromosomes were not yet perfected. Today few experimental journals are issued which do not contain at least one article per issue on one of these topics, and several symposia have been devoted to these or similar subjects. The fact that the Brookhaven National Laboratory devoted its 1951 symposium to the same topics does not, however, bespeak a lack of originality in choosing subject matter; rather it indicates that frequent reassessment in this rapidly advancing field is necessary and desirable. To gain this end, the presentation of personally collected data has been subordinated to an over-all attempt at a general appraisal. The result, in general, has been to give a group of provocative essays which survey rather than dissect a particular subject, with an emphasis on synthesis and correlation, unexplored possibilities, and, where possible, frank speculation. The addition of the discussions following each presentation furthers the value of the essays, since they tend to clarify particular points made in the body of the talks.

In general, the essays can be classified into three groups. The first includes those by K. Stern and Schultz, and from a speculative point of view they form the two most interesting papers of the symposium. They deal largely in nuclear activity as it relates to the larger problems of cellular biology: gene action, nuclear-cytoplasmic interactions, and differentiation as governed by the chemistry of the nucleus. That by Schultz is a particularly penetrating analysis of the present state of our genetic knowledge and how this might relate to other areas of experimental biology. Fourteen of the papers are largely chemical in content, dealing with the nucleic acids, proteins, and enzymes of the nucleus, the chemistry of phage metabolism, and the nature of the bacterial transforming factor. What with the wealth of research now being conducted in the field of cytochemistry, it is not yet possible to evaluate critically the scattered and often conflicting data and hypotheses, but the current optimism is both gratifying and justified. Three papers are strictly structural in approach, and deal respectively with newer ideas on the lampbrush chromosomes of amphibians, the submicroscopic structure of the spindle, and the nature of the bacterial nucleus. A single paper considers optical techniques for quantitative measurements of absorbing substances within single cells.

In contrast to the annual symposia of the Oak Ridge biological group, the Brookhaven symposium has touched upon the radiation aspects of nuclear study only

briefly. It is to be hoped that the more general point of view of the Brookhaven symposium can be maintained.

C. P. SWANSON

INTRODUCTION TO AGRICULTURAL BIOCHEMISTRY. *By R. Adams Dutcher, Clifford O. Jensen, and Paul M. Althouse. John Wiley & Sons, New York; Chapman & Hall, London.* $6.00. xii + 502 pp.; ill. 1951.

This volume follows the general plan of an earlier textbook by Dutcher and Haley written in 1932. Considerable attention is given in Part I to general background material, including the historical development of agricultural chemistry, the chemistry of living matter, and the physical states of matter. Part II is devoted to the plant, and introduces the biochemistry of seed germination, the soil and its relation to plant growth, fertilizers, and plant metabolism. Part III treats animal biochemistry as related to foods, digestion, the chemistry of blood, and the metabolism of carbohydrates, lipids, and proteins.

In a field as diverse as biochemistry, any attempt to present so vast a range of subjects is of necessity limited in the coverage of individual topics. The authors have done remarkably well, however, in surveying the subject matter, and the textbook should prove adequate for a first course in biochemistry.

R. VAN REEN

AGRICULTURAL CHEMISTRY. *A Reference Text. Vol. II. Practical Applications of Agricultural Chemistry. By Donald E. H. Frear. D. Van Nostrand Company, Toronto, New York, and London.* $9.50. viii + 588 pp.; ill. 1951.

In the words of the editor, "The first volume of this work [*Q.R.B.*, 26: 432. 1951] deals with the more fundamental phases of agricultural chemistry, including the chemistry of the basic compounds of biological importance, and of the physiological processes of plants and animals. The second volume is devoted to the practical applications of agricultural chemistry. Thus the first volume probably will be most useful to the teacher and research worker, while the second will be of more interest to the practicing agricultural specialist." There are 5 parts, containing 24 chapters written by 23 specialists.

Part I deals with the chemistry of various products —seeds, cereals, fruits, vegetables, forage crops, meat, milk, eggs, and poultry. This part is expectionally well done and contains a wealth of information, especially in tabular form. Although this part constitutes only 29% of the pages, it includes 48% of the tables.

Part II covers fertilizers and soil amendments. The break-down here is in terms of the types of fertilizers—nitrogen, potassium, phosphorus, mixed, lime, and minor elements. Plant nutrition as such is scattered among these chapters.

Nutrition of farm animals is the subject of part III. Here the break-down is the animal—dairy cattle, beef cattle, horses and mules, sheep and goats, poultry, swine, domestic, and fur-bearing. Animal nutrition as such is scattered among these chapters.

Part IV deals with insecticides, fungicides, and herbicides, but, surprisingly enough, not with plant hormones. Considerable chemistry is presented here, and clearly. The physiological effects on insects are not given much consideration.

The last section covers patents and chemurgy briefly.

All chapters, taken by themselves, are well done, many of them exceptionally so. The unity of the book as a whole, however, leaves something to be desired. For example, the chemistry and physiology of the rumen are discussed in 3 chapters under the headings of three different ruminants. Also, the use of urea in the feed of ruminants is in 3 places. This would not be so bad if all these places appeared in the index. The latter, however, has one entry each for rumen and urea. On the subject of the index, I was keenly disappointed to pass through 573 pages of glowing, informative, up-to-date text, and then come upon an inadequate index. These books are avowedly "reference texts," to which readers will turn to "look something up." Hence an adequate index is of prime importance. The "index index" (number of index entries per page of text) for volume I was 1.75; for volume II it is 2.46, indicating improvement. However, a comparable text in this same general field has 2.70, and the 1950–51 *Yearbook of Agriculture* has 3.12. Other examples of index deficiency are the rumen and urea mentioned above.

Nevertheless, this is a good book. The materials are well chosen for the intended readers—graduate students, county agents, extension workers, industrial research and sales people. The paper is good, so is the printing, and the text and tables make smooth and pleasant reading.

J. J. WILLAMAN

BIOCHIMIE MÉDICALE. *Cinquième Édition. By Michel Polonovski, P. Boulanger, M. Macheboeuf, and J. Roche. Masson & Cie., Paris.* 4600 fr. 813 pp.; ill. 1952.

The success of this French textbook of biochemistry for medical students and physicians is indicated by the appearance of a 5th edition within a few years of the publication of the 4th (*Q.R.B.*, 24: 383. 1949). Though the organization is essentially unchanged, the text has been thoroughly revised and brought up to date in

most of the fields covered. A few of the newer topics discussed include: the role and significance of "energy-rich phosphate bonds" (complete with wiggles), acetyl coenzyme A, Sanger's work on the structure of insulin, electrophoresis of proteins on filter paper, the use of stable and radioactive isotopes, etc. In general, the discussions are thorough and critical. The authors have taken pains to integrate related facts into a coherent whole and have been essentially successful in avoiding dull recitals of data of questionable pertinence. References to review articles are given at the ends of most chapters; there are few references to the original literature.

Though revised and somewhat improved, the discussion of matters pertaining to physical chemistry is still not satisfactory. There has been, in addition, uncritical adoption of some inappropriate and inaccurate terms found in articles written in American or in English. In spite of these defects and in spite of minor typographical errors, this textbook presents an adequate picture of most of the fields of biochemistry of importance to present or potential physicians.

FRANCIS P. CHINARD

BIOCHEMISTRY OF THE TEETH.

By Henry M. Leicester. The C. V. Mosby Company, St. Louis. $5.00. 306 pp. + 3 pl.; text ill. 1949.

Essentially a descriptive treatise in which a considerable literature is abstracted. The subject and author indices should be useful to interested specialists.

DIE PORPHYRINE IN DER TIERHEILKUNDE.

By Raphael Koller. Urban & Schwarzenberg, Wien. 216 pp. + 1 pl. 1948.

This little monograph is essentially a review of the biology of porphyrins. It is extremely brief, appearing to be almost an annotated bibliography. The references at the end of each chapter are complete and appear to be accurate. The author has included some of his own observations in the veterinary field in scattered places in the book. Because of the association of the author with Hans Fischer and his coworkers, and his access to well-organized libraries in this field, the book contains many interesting facts. Among other things, Koller describes the accumulation of porphyrin, not only in decaying meat or flesh, but even in sterile, frozen meat. In view of our common practice of the cold storage of meats and meat products, these observations may be of importance. The book would be a good reference work if it had been indexed. Lacking an index, it is almost worthless as such.

FRANK H. J. FIGGE

BIOCHEMICAL PREPARATIONS. *Volume Two.*

Edited by Eric G. Ball. John Wiley & Sons, New York. $3.00. 109 pp.; ill. 1952.

This publication represents the second of a series devoted to the methods of preparing compounds of biological interest. As was the case in the first volume, the procedures submitted by the authors were checked in a second laboratory by an independent investigator. Sources of raw material and the preparation of necessary intermediates are described in detail, eliminating, therefore, the necessity of checking several other reports in the literature. Included among the twenty-five preparations reported are: cytochrome c, crystalline lactate dehydrogenase, sodium pyruvate, phosphoryl-enolpyruvic acid, l-a-glycerophosphoric acid, C^{14} uniformly labeled sucrose, and reduced diphosphopyridine nucleotide.

The biochemists and others working in this area will find this second volume a useful and necessary addition to the laboratory library. This is true even if it be needed only as a guide for checking the purity of commercially prepared products which are rapidly becoming available to the biochemists.

W. D. MCELROY

PAPER CHROMATOGRAPHY. *A Laboratory Manual.*

By Richard J. Block, Raymond LeStrange, and Gunter Zweig. Academic Press, New York. $4.50. x + 195 pp. + 2 pl.; text ill. 1952.

The purpose of this monograph is to provide a readily accessible source for some of the many uses and adaptations of paper chromatography which have appeared during the past ten years. The authors are to be congratulated on presenting a concise yet sufficiently detailed account of the applications of this important technique. It will certainly serve as a useful laboratory manual for all chemical laboratories.

The first 4 chapters are concerned with the theory of chromatography and the general and quantitative methods used in this field. One of the important features of the book is that the authors have described only those procedures which have been used extensively and have proven their value in the laboratory. In addition, those procedures which require relatively simple equipment and available reagents take precedence over more elaborate designs. Included in the remaining chapters are procedures for amino acids, amines, proteins, carbohydrates, aliphatic acids, steroids, purines, pyrimidines, phenols, aromatic acids, porphyrins, antibiotics, vitamins, and inorganic ions.

W. D. MCELROY

ORGANIC SYNTHESES. *An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Volume 29.*

Edited by Cliff S. Hamilton. John Wiley & Sons, New York; Chapman & Hall, London. $2.50. vi + 119 pp.; ill. 1949.

The twenty-ninth in the series of authoritative volumes dealing with successful procedures of interest in preparative organic chemistry. The subject index is a cumulative index comprising material from Vols. 20 through 29 of this series (i.e., subsequent to Collective Volumes 1 and 2).

FUNDAMENTALS OF ORGANIC CHEMISTRY. *A Brief Course for Students Concerned with Biology, Medicine, Agriculture, and Industry.*

By James Bryant Conant and Albert Harold Blatt. The Macmillan Company, New York. $4.00. x + 413 pp. 1950.

Adequately designed for a brief course for certain students who do not plan to become professional chemists, such as students of biology.

LABORATORY MANUAL OF ELEMENTARY ORGANIC CHEMISTRY. *Second Edition.*

By George Holmes Richter. John Wiley & Sons, New York; Chapman & Hall, London. $1.80 (paper). x + 146 pp.; ill. 1951.

As in the case of the *Textbook of Organic Chemistry* by the same author, this laboratory manual was designed specifically for the student specializing in the biological sciences. The experiments are devoted in most cases to the preparation of substances of biological interest. This has been done, however, without neglecting the adequate coverage of the principal organic reactions. Preliminary experiments cover the usual subjects of melting point determination, fractional distillation, and the determination of the elements most frequently encountered. The organic preparations include urea, DDT, veronal, hippuric acid, and other medicinals.

R. VAN REEN

BORON TRIFLUORIDE AND ITS DERIVATIVES.

By Harold Simmons Booth and Donald Ray Martin. John Wiley & Sons, New York; Chapman & Hall, London. $5.00. x + 315 pp.; ill. 1949.

A conscientious and authoritative summarization of the chemistry of this important compound, with the literature covered through 1947.

COLLOID SCIENCE. *Vol. I. Irreversible Systems.*

Edited by H. R. Kruyt. Elsevier Publishing Company, Amsterdam, Houston, New York, and London. $11.00. xx + 389 pp.; ill. 1952.

The subtitle of this volume, Irreversible Systems, is given to indicate that it treats principally the lyophobic colloids. The authors contributing to this volume are Kruyt, Jonker, and Overbeek. The organization of this work is more like the older classical works in colloid chemistry than it is like some of the more recently published works. It appears to supplement most admirably works like *Colloid Science* (Alexander & Johnson), in that it treats in a rigorous and detailed way much of the material not more than mentioned in the former work.

Because of the importance of colloid chemistry for many of the phenomena in biological science, this volume will undoubtedly become an important reference work. It is not possible to mention all the points in which the discussion appears most applicable to biology, but the following sections appeared most noteworthy: the birth and growth of sol particles; the scattering of light by colloidal solutions; the influence of the orientation of particles on the optical properties of solutions; ion exchange; the minimum in potential curves for large distances between particles; and non-Newtonian flow and visco-elastic behavior of flocculated systems.

L. J. MULLINS

COLLOIDAL DISPERSIONS.

By Earl K. Fischer. John Wiley & Sons, New York; Chapman & Hall, London. $7.50. viii + 387 pp.; ill. 1950.

An authoritative treatment. Numerous practical aspects are considered, including descriptions of technical apparatus. A wealth of material of an empirical nature, characteristic of the subject, is presented with essentially a physical chemical and engineering approach.

UNFAMILIAR OXIDATION STATES AND THEIR STABILIZATION.

By Jacob Kleinberg. University of Kansas Press, Lawrence. $3.00. ix + 131 pp.; ill. 1950.

This work treats of compounds of certain important elements in "unfamiliar" states of oxidation.

PATHOLOGIE CHIMIQUE. *Tome I and II.*

Edited by Michel Polonovski. Masson & Cie., Paris.

11,000 fr. (cloth); 9,800 fr. (paper). xii + 1603 pp.; ill. 1952.

The sustained growth of biochemistry, particularly during the past two decades, has among other things led to the elucidation of many important clinical problems. In order that this progress may continue, it is necessary that workers in biochemistry and in clinical medicine should keep at least a certain measure of reciprocal understanding and rapport. It is difficult enough for first-year medical students to obtain an adequate grasp of biochemical principles and endeavors. It is even more difficult for the practicing physician and the clinician, realizing the significance of biochemical advances to their own work, to renew their acquaintance with matters forgotten and to extend their understanding to recent developments. These 2 volumes represent an attempt by Polonovski and his collaborators to bring the fundamentals and the recent developments within the grasp of the graduate physician. The attempt, by and large, is successful. The following summary of the contents will give some idea of the organization and scope of this encyclopedic work.

The first volume is divided into 3 major sections: metabolism and its deviations from the normal; general aspects of pathological physiology; and the biochemistry of disease. In the first section there are reviewed the following fundamental topics: significant qualitative aspects of intermediary metabolism; water and mineral metabolism, with a brief description of the major clinical features associated with changes in the concentration or total amounts of water, and of sodium, potassium, chloride, and bicarbonate ions; a discussion of the Starling hypothesis and of the factors responsible for edema; phosphates, calcium, and magnesium; iron, copper, sulfur, iodine, and other trace elements; vitamins and related deficiency diseases; hormones and their interrelations; enzymes and such biochemical defects as alkaptonuria. The second section is divided into two parts: the first covers pregnancy (both normal and abnormal); fetal, newborn, and infant development; the changes at puberty; and finally the biochemical changes associated with senescence. The second part is essentially an application of the topics in the first section to certain clinical problems. The subjects covered, with emphasis on biochemistry, include deficiency disorders, physical work and fatigue, the effect of climates, stress, effects of ionizing and nonionizing radiations, ultrasonic effects, toxic agents and "detoxication" mechanisms, shock, infection, immunity, allergy, viruses, parasites, and cancer. The third section is largely on metabolic disorders: acid-base balance, disorders of amino acid metabolism, porphyrins, gout, starvation, obesity, disorders of fat metabolism, amyloid hyperglycemia, and the urinary excretion of carbohydrates.

The second volume begins with an account of endocrine disorders: diabetes mellitus, the syndromes of the anterior and posterior pituitary, male and female gonad function, thyroid disease, the parathyroids, adrenocortical and medullary disorders, and the possible role of the thymus. There follows a chapter on the autonomic nervous system and then there are 8 chapters on the disorders of blood cells and of the reticulo-endothelial system. The latter chapters cover such subjects as the life cycle of the red cell, anemias and polycythemia, leukemias, disorders of the spleen, multiple myeloma, and blood coagulation. A large section is devoted to specific organ diseases: the digestive tract, from disturbances of the secretion of saliva to diarrhea; liver diseases; chronic diseases of blood vessels; heart disease; pulmonary diseases; arterial hypertension; and renal diseases. There follow 7 chapters on the nervous system, muscles and the various atrophies and dystrophies, joints, ossification, teeth, skin, and sense organs. Finally there is an appendix containing data on the constituents of blood in adults and in infants.

In general, the articles by the 33 contributors are well handled, factual, and clearly and logically presented. Controversial points are mentioned, but there is a minimum of speculation. In nearly all the articles dealing primarily with clinical entities, i.e., in the second volume, a happy blend has been achieved of biochemistry, physiology, pharmacology, and clinical medicine. Matters of therapy are brought in only in so far as they illustrate important principles; symptomatology is discussed to the extent that it can be related to chemical or physiological findings. Clinical tests are discussed both with respect to their rationale and to their significance; their limitations are also pointed out. For example the errors in the fractionation of the plasma proteins by Howe's procedure are stressed. References to the original literature are particularly well selected and are restricted to significant contributions; the greatest number are to articles published in the United States, both for biochemistry and for clinical investigations. In the matter of reviews, for obvious reasons, references to those in French are somewhat more numerous. Many of the references are to articles published in 1950, and quite a few to articles published in 1951.

The major criticism of the work is that there is insufficient emphasis on the natural history of the various disorders discussed and on the effects of treatment. It would be quite helpful if, in the promised subsequent editions, there could be included charts or graphs to show the variation of the biochemical data with time and with specific therapy. Such quantitative information would be most useful in those conditions where disorders of acid-base and of electrolyte balance are important features. More emphasis could also be placed on disorders of intracellular fluid composition. No important errors of fact and relatively few typographical errors were noted; most of the latter occur in the spelling of English or American names. The

format is convenient, the binding sturdy, and the type sufficiently large to allow reading without strain. The subject index is most complete; it covers 46 pages and has over 5500 entries.

It is quite apparent that the French biochemists and clinicians who have contributed here have taken great pains in order to achieve their aim of presenting biochemistry intelligibly to clinicians. In so doing, they have set a high standard to be met by any comparable work in English. For these reasons, these volumes are recommended not only to those clinicians who read French with some ease, but also to all biochemists who take part in the training of physicians. They will find in this outstanding contribution a measure of that integration of biochemistry and clinical medicine so often sought and so rarely achieved.

FRANCIS P. CHINARD

IODINE CONTENT OF FOODS. *Annotated Bibliography 1825–1951 with Review and Tables.*

Chilean Iodine Educational Bureau, London. 21s. viii + 183 pp. 1952.

This annotated bibliography lists 326 papers on the iodine content of food. These papers, from 26 countries, contain data for 1207 different food items. To facilitate a comparison between the findings of different workers, the iodine content given in the tables is expressed uniformly as micrograms per kilogram of food on the basis of either fresh weight or dry weight. Exceptions to the rule relate to oils, and in some instances to eggs, in which the content of iodine is expressed per liter or per egg. The common as well as the scientific names ascribed to foods are those given by the original authors; although in some cases—for example, in Hawaiian fish—the authors of the bibliography have identified vernacular names with internationally accepted scientific names. One regrets that, due to the anonymity of the author or authors, credit cannot be given them for this excellent little book. It should be of interest mainly to nutritionists and biochemists, to whom it is heartily recommended.

WALTER FLEISCHMANN

MICROBIOLOGY

THE YEASTS. *A Taxonomic Study.*

By J. Lodder and N. J. W. Kreger-Van Rij. North-Holland Publishing Company, Amsterdam; Interscience Publishers, New York. $19.80. xi + 715 pp.; ill. 1952.

The yeast collection of the Centraalbureau voor Schimmelcultures, maintained in the laboratory of Professor Kluyver at the Technical University of Delft, has been subjected to intensive study for over 20 years. From these investigations there emerged Stelling-Dekker's *Die sporogenen Hefen* (1931), and two succeeding volumes on *Die anaskosporogenen Hefen* by Lodder (1934) and by Diddens and Lodder (1942). These works cleared up much existing taxonomic confusion, and at the same time established a simple and reasonably standard methodology for the identification of these microorganisms. The present magnificent volume is a fitting culmination, and will undoubtedly remain for many years the authoritative work on the classification of yeasts. It represents a condensation of the 3 earlier volumes (which contained detailed descriptions of every strain then in the collection), brought up to date by the inclusion of much new material.

After a brief introductory chapter in which an attempt is made to define a yeast—no easy task—there are 3 very useful chapters of a general nature, dealing with methodology, the problem of variation from a taxonomist's standpoint, and the main outlines of the classification adopted through families, subfamilies, and tribes. Detailed descriptions of the genera and species in the 3 families recognized by the authors then follow. The descriptions are admirable. Each species is introduced by a list of synonyms (often of staggering length), an account of its original description, and a survey of its subsequent taxonomic vicissitudes. This leads to a *standard description*, based on the authors' studies (generally of numerous strains), and supplemented by a discussion which brings out points of agreement or disagreement with earlier workers. Each specific description concludes with a listing of the origin of the strains studied, and a designation of the type strain. Morphological features are illustrated by excellent line drawings. The generic descriptions are carried out in the same thorough and systematic fashion and the account of each genus terminates with a list of papers cited. An author index and an index to the names of taxa are provided.

The decision to publish this book in English rather than German is a welcome one, fully justified by the shift in the scientific balance of power which has occurred during the past 20 years. There are a few minor faults of usage or construction, but none sufficiently serious to cause misunderstanding.

Lastly, the North-Holland Publishing Company deserves congratulations for the superb typography and format. Everything possible has been done to make matters easy for the reader, and in addition the book is a pleasure to look at. Many American publishing houses could study it with profit—perhaps not for themselves, but certainly for their potential readers.

R. Y. STANIER

APPLIED MYCOLOGY AND BACTERIOLOGY. *Third Edition. Originally compiled by L. D. Galloway and R. Burgess;*

revised by L. D. Galloway. Leonard Hill, London. 12s. viii + 184 pp.; 8 pl.; text ill. 1950.

This well-written little book seems mainly designed as a general explanatory treatise for chemists and others who encounter the effects of microorganisms in industry, but who are handicapped by a lack of training in the field of microbiology. As an introduction to the field it can be recommended, although it can only "hit the high spots" owing to its brevity of treatment. The material is of a generally descriptive nature. The first 8 chapters describe microorganisms and their effects in a general way. The final 6 chapters cover food, fermentation, and textile industries, hygiene, and agricultural applications.

WALTER C. TOBIE

BACTERIA.

By Stanley Thomas and Thomas H. Grainger. The Blakiston Company, New York and Toronto. $5.50. x + 623 pp.; ill. 1952.

This is an introductory textbook for mixed undergraduate classes of diverse professional orientation. The main stress is upon bacteria in the strict sense, but 4 of the 35 chapters deal with other microorganisms. The book is written in an interesting and at times very lively style, and contains a surprising amount of solid information for an elementary work. The material is well up to date. There is a good account of chemotherapy and antibiotics, as well as a chapter on the possibilities of bacterial warfare. After each chapter there are references to the journal literature, as well as to textbooks and monographs. There is an abundance of good illustrations, and an adequate index. A few doubtful interpretations were noted, but no outright errors. In general, the textbook is of very superior quality and can be highly recommended.

WALTER C. TOBIE

GENERAL BACTERIOLOGY LABORATORY MANUAL. *Second Edition.*

By L. S. McClung. W. B. Saunders Company, Philadelphia and London. $2.50. x + 134 pp.; ill. 1952.

This manual has a spiral binder, and is well printed on both sides of the paper. It contains 59 laboratory exercises for an introductory one-semester course in general bacteriology given at Indiana University. Algae, molds, and yeasts are each given one exercise. The procedures are well planned, and those interested in selecting a manual for their own laboratory classes would do well to examine the present work. Spaces are left for sketches and observations to be entered. Very few errors or doubtful points were noted, although it is not quite correct to indicate (p. 46) that little is known of the chemistry of non-carotenoid bacterial pigments.

WALTER C. TOBIE

PARASITOLOGY

VETERINARY PROTOZOOLOGY. *Revised Edition.*

By Banner Bill Morgan and Philip A. Hawkins. Burgess Publishing Company, Minneapolis. $5.00. x + 187 pp. + 1 pl.; text ill. 1952.

The present edition of this handbook is organized along the same lines and is approximately the same size as the first edition, (*Q.R.B.*, 23: 390. 1948) which appeared in 1948. Among the changes are an improved plate on the life cycle of a coccidian parasite, a new chart summarizing the characters of the coccidia occurring in poultry, a description of the complement-fixation test for anaplasmosis, and a treatment schedule organized according to the drugs and to the host. A distinct improvement is found in the section devoted to the classification of protozoa, where the important characteristics of each category from class to genus are now described. As in the earlier edition, the practical aspects of veterinary protozoology are emphasized, and for this reason the book should be valuable to those interested particularly in the diagnosis and treatment of the protozoan infections of animals.

Following the introductory chapter, which presents a quick review of the Protozoa in general, there are 7 chapters devoted to the protozoan parasites of the horse, cattle, sheep and goats, swine, dogs and cats, poultry, and fur bearers. In each case the parasites are presented according to their taxonomic position. Wherever the available information and importance of the species warrants, the discussion is efficiently organized according to the following outline: synonyms, disease, morphology, life cycle, symptoms and lesions, diagnosis, treatment and control, and general remarks. Species of lesser importance are generally described and discussed in a few paragraphs.

In the last chapter, methods of diagnosing protozoan infections are presented. The various techniques are described simply but with sufficient detail to be used as working guides in the laboratory. The value of this chapter would be increased if it were provided with a bibliography like all the previous chapters. It is a common experience that one often needs more detailed directions than can be given in a textbook in order to perform properly some of the more intricate laboratory procedures.

The Appendix consists primarily of a parasite-host list and a schedule of treatments for various infections. The parasite-host list simply relists all the parasites dealt with in the text and in the same order. In addition, the classes to which the parasites belong and their

location in the host are given. It is not clear what contribution such a list makes, since it does not provide any new or simple way by which one could find information about a species that might be known only by name. For this purpose the index would need to be consulted. The index appears to be quite complete, and references to illustrations are clearly marked. Twenty-one plates of diagrammatic outline drawings are provided to illustrate primarily the morphology of the organisms, though 2 life cycles are also included.

MORRIS GOLDMAN

A MANUAL OF PARASITOLOGY FOR MEDICAL STUDENTS AND BEGINNERS.

By Mark M. Schapiro. Grune & Stratton, New York. $5.50. xii + 140 pp.; ill. 1951.

This book was designed for the medical student who is confronted with the task of learning the basic principles of parasitology in a short time. Shapiro has condensed the information usually found in longer textbooks to the essential details of morphology and the diagnostic characteristics of the protozoan and helminth parasites of man. Illustrations of the various parasites are included. Any instructor in medical parasitology will agree that such a manual would be of invaluable aid in teaching such a comprehensive subject in a relatively brief time. However, there are many inaccuracies which would, in some cases mislead the beginning student. The sections on techniques and on serology are vague in many places, and would hardly be of any real benefit to a beginning student. Since this work was designed as a manual especially for medical students, it would be expected that more information on diagnostic procedures would have been included. Much of the morphological descriptions deals with structures or stages that would interest only a parasitologist. For example, several paragraphs are devoted to the morphology of adult filariae, which would rarely if ever be seen, and only a brief description of the microfilariae is given. The common methods of differentiating microfilariae are also dispensed with in favor of the more complicated measurement of fixed points. No mention of periodicity of the circulating microfilariae is made—a point to be reckoned with in diagnosis. Schapiro has also taken liberty with the accepted forms of scientific writing. The names of families, genera, and species are not capitalized or italicized in much of the text, and the genera *Endamoeba*, *Endolimax*, *Iodamoeba*, and *Dientamoeba* are designated as species. Although the sporozoa are mentioned in the general discussion of the intestinal protozoa, no further mention is made of coccidia.

The thought and aim behind the writing of this manual are good, and such a condensed text has a valuable place in medical school programs. Unfortunately, the errors in this particular work make it difficult to recommend it for any medical student or beginner in the field.

MOLLUSCICIDES.

By Alan Mozley. H. K. Lewis & Company, London. 9s. 87 pp.; ill. 1952.

To combat some of the injurious insects many insecticides, such as the well-known DDT, are employed. In like manner substances called molluscicides are needed to check the damage done by some few of the many kinds of freshwater snails that harbor harmful flatworms; namely, the few that carry certain stages in the life cycle of the worms causing the disease schistosomiasis, or bilharzia, so prevalent in all tropical lands as seriously to retard the advance of civilization into hot countries; and the better known disease, fascioliasis, or liver rot, due to the liver fluke. While the former is restricted to hot countries, the latter spreads far north into the most civilized lands, such as Great Britain, where it may ruin a prosperous farmer by attacking his sheep and cattle.

The author of this little book is a malacologist of wide experience not only in the tropics but in Canada and Siberia. For a decade he has been carrying on research on molluscicides in Egypt, the Sudan, and in East Africa. In 1944 he published an extensive monograph, *The Control of Bilharzia in Southern Rhodesia* (307 pp.) printed there in Salisbury. Also in 1951 he produced a small book *The Snail Hosts of Bilharzia in Africa; their Occurrence and Destruction* (see *Q.R.B.*, 26: 439. 1951). In press is another demi-octavo volume, *A Background for the Prevention of Bilharzia.*

The present book is very clearly written and printed and deals with such topics as The Field for Molluscicides; Practical Considerations in the use of Molluscicides; Possible Danger to Human Beings; Molluscicides of Vegetable Origin; Synthetic Organic Molluscicides; Inorganic Molluscicides; Methods of Application; Destruction of Field Pests (slugs, garden snails, *Achatina*); Emergency Measures, in War, etc., when the best molluscicides may not be available.

While research into the field of molluscicides is now very active and new methods are to be expected, the author holds that at the present moment copper salts (especially the sulfate) are by far the best. However, he notes in an Addendum that recent workers in Japan, in combatting the bad snails in irrigation ditches in the rice fields, make little use of copper sulfate and find calcium cyanamide to be better. Others find dinitro-o-cyclohexylphenol excellent. Mozley concedes that such substances may substitute for or supplement copper salts in some situations. The author refers to some 20 recent papers but attempts no general bibliography. An appendix deals with the collection and identifica-

tion of liver fluke snails, which the author investigated in northern Great Britain.

Anyone living in tropical lands where bilharzia is rampant can profit by consulting this little book, especially since the author explains that it requires extreme care to escape contamination—wearing rubber boots and gloves where a drop of pond water falling on one's skin may cause infection. All health authorities, physicians and veterinarians in the tropics should add this book to their libraries.

E. A. ANDREWS

LIST OF PARASITES OF DOMESTICATED ANIMALS IN NORTH AMERICA. *Second Edition Revised.*

By Edward A. Benbrook. Burgess Publishing Company, Minneapolis. $1.75 (paper). iii + 63 pp. 1952.

This is a rather complete listing of the protozoan, helminth, and arthropod parasites of the common domestic animals in North America. The specific scientific name, common name, and general classification as protozoan, trematode, or cestode, etc., is given for each parasite, as well as its specific location in the host. The list is arranged by animal hosts on a body-systemic basis so as to list all the parasites of a particular animal found in a given area of the body. In some cases, the parasite is listed under the organs or tissues through which it may pass during some pathological phase of the life cycle. Recent changes of a few generic names, e.g., *Liponyssus* to *Bdellonyssus*, have not been indicated; however, the list should be of value to students and teachers as a reference or check-list.

DOROTHY M. MELVIN

TEXTBOOK OF CLINICAL PARASITOLOGY. *Second Edition.*

By David L. Belding. Appleton-Century-Crofts, New York. $12.00. viii + 1139 pp. + 4 pl.; text ill. 1952.

The second edition of this excellent textbook has been revised to include advances in the field of parasitology during and after World War II. New material on amoebiasis, trypanosomiasis, malaria, schistosomiasis, and other diseases has been included, as well as recent technical developments and new chemotherapeutic agents. A new chapter on insecticides and repellents has also been incorporated. As in the first edition, the introduction deals with parasites and parasitism in general, followed by separate sections on the protozoa, helminths, arthropods, and technical developments. The book covers the extensive field of clinical parasitology adequately, with emphasis on the more common parasites. The detailed morphology of the parasites and their life cycles, and special attention to the pathology, diagnosis, treatment, and epidemiology of the organisms makes the text extremely valuable to medical as well as academic personnel. Perhaps the most significant feature of the book is the use of keys and tables for presenting the material on identification, mode of transmission, pathology, etc., wherever possible. The maps showing the geographical distribution of the various organisms should also be of interest. These features, plus the grouping and arrangement of the text, give ready access to the information.

The only adverse criticism might be the failure to include in the entomology section recent generic changes, such as *Theobaldia* to *Culiseta*, *Cochliomyia* to *Callitroga*, and *Liponyssus* to *Bdellonyssus*.

The extensive references and the adequate treatment of the subject material make this an invaluable reference and textbook to anyone concerned with parasitology.

DOROTHY M. MELVIN

HEALTH AND DISEASE

MEDICAL MILESTONES.

By Henry J. L. Marriott; foreword by Sir Alexander Fleming. The Williams & Wilkins Company, Baltimore. $3.50. xii + 293 pp.; ill. 1952.

"In too many publications for the lay reader the truth is to some extent sacrificed to the dramatic story," observes Sir Alexander Fleming in the Foreword to *Medical Milestones*, a book conceived for the purpose of rectifying this situation. The non-medical reader is introduced to the current status of medical progress by some 20 chapters embracing a broad spectrum of medical endeavor. Among the subjects treated are antibiotics, heart surgery, the Rh blood factor, hormones and cancer, and British Anti-Lewisite. All these are undoubtedly presented less luridly than by certain journalistic schools. Certainly Marriott does well to emphasize to his audience the detrimental phases of certain medical advances, particularly the genetic implications of insulin therapy. Perhaps unavoidable in such a wide-ranging book by a single author are certain errors of interpretation and fact. For example, one finds DDT discussed without reference to insecticide resistance and, in the discussion of cancer, the organizer is classified as being certainly a steroid. Such matters recede into relative unimportance beside the argument that diet is largely responsible for civilized man's morbid state of health. One is left with the impression that while the author may be completely unmoved by the dramatic aspects of the majority of medical advances, he cannot keep his hands in his pockets all the time.

J. F. CASE

AN ATLAS OF GENERAL AFFECTIONS OF THE SKELETON. *By Sir Thomas Fairbank. The Williams & Wilkins Company, Baltimore.* $10.00. xx + 411 pp.; ill. 1951.

With the advent of roentgenography, there came to light a number of patients who had generalized anomalies of the skeleton. The etiology in these conditions was generally obscure, but they were reported usually as clinical descriptions with emphasis on the x-ray and pathologic findings. A number of authors assembled some of these case histories and presented them as clinical entities. There was a lack of uniformity in the syndromes and an absence of definite lines of demarcation, so that considerable confusion still exists.

Fairbank's book constitutes a good attempt to bring order out of this confusion. In it he has used 184 cases to illustrate the 84 categories into which he has gathered the clinical pictures. He believes the 84 groups to be definite syndromes. Each group is introduced by a concise presentation of the important facts known about the clinical features, the pathological and radiographic characteristics, and the diagnostic criteria. The case reports are used to illustrate the diseases and consist chiefly of x-ray reproductions with occasional pictures of specimens or patients. Legends explain the significance of the illustrations, which are well chosen and profuse enough to make the volume veritably an atlas.

A valuable contribution is to be found in the introduction. Because of his many years of study in the field of generalized skeletal changes, Fairbank is qualified to write on this subject with authority. In the introduction he has 6 tables: The Classification of General Affections of the Skeleton, as far as possible, on an Etiologic Basis; Blood Chemistry in Various Affections of the Skeleton; Dwarfism; Increased Bone Density; Collapse of One or More Vertebral Bodies; and Multiple Fractures. The text built about these tables is very informative. In a field as unstandardized as this, the reader may take exception to an occasional statement. The critical student, nevertheless, will find the volume to be a real guidebook in a relatively unexplored field.

I. WILLIAM NACHLAS

YOUR WEIGHT AND YOUR LIFE. *A Scientific Guide to Weight Reduction and Control.*

By Alfred L. George. W. W. Norton & Company, New York. $2.95. 272 pp.; 1951.

This is a popular presentation which strikes at the heart of the problem of overweight and weight reduction. The person who is considerably overweight and excuses his condition on the basis of glandular trouble, heredity, or an abnormal metabolism will get little support from George. The gist of the book is that overweight results from overeating since the only source of fat is food. An adequate discussion is given of the weight problem in relation to longevity, the incidence of heart disease, diabetes, brain hemorrhage, and kidney disease. A 52-page appendix gives sample menus and the caloric content of common foods.

R. VAN REEN

ATLAS OF GYNECOLOGIC PATHOLOGY. *Color Film Library and Descriptive Manual.*

By Anthony V. Postoloff and David H. Nichols. The Williams & Wilkins Company, Baltimore. $80.00. x + 74 pp. + 100 color slides and index. 1952.

This volume attempts a new technique for the pathologic atlas by using kodachrome lantern slides for illustrations. While such atlases usually cover only a limited and complex area of a larger field, (as do Barzilai's and Selye's atlases of ovarian tumors), this atlas claims by its title to cover the whole field. A gynecologic pathology that ignores the vulva and vagina, the cyclic changes in endometrium and ovary, and the simple ovarian cyst, however, can scarcely be considered complete. I suspect the cost of the illustrations may have had something to do with the lack of completeness.

The accompanying text reads like a manual for a medical school course in gynecologic pathology. The usual brief résumés of the pathology of the pelvic organs are followed by protocols of patients and morphologic descriptions in "telegraphese" of the lesions illustrated. The illustrations, while technically excellent and usually fairly representative, can hardly substitute for the careful study of whole microscopic slides offered by a formal course.

The authors have hit upon a novel idea in the area of teaching aids, and their book will probably find use in smaller hospitals without representative gynecologic material, or in the hands of specialty board candidates in outlying districts and individuals interested in informal review or instruction. For others interested in this field, Novak's *Gynecological and Obstetrical Pathology* and one of the previously mentioned atlases of ovarian tumors will continue to be the standard works.

GEORGE W. CORNER, JR.

DIAGNOSIS AND THERAPY OF GYNECOLOGICAL ENDOCRINE DISORDERS. *The American Lecture Series.*

By C. L. Buxton and E. T. Engle. Charles C Thomas, Springfield, Ill. $2.00. viii + 62 pp. 1949.

This is another of the American Lecture Series monographs on medical problems, monographs noted for their clarity, brevity, and excellent typography, but not for inexpensiveness. This one is a careful exposition of gynecological endocrine therapy as practiced at the

Sloane Hospital for Women in New York City. The book is intended for the general practitioner, with the internist thrown in for good measure. I imagine, however, that it will appeal more to the medical and postgraduate student and to the clinician who is preparing for specialty board examinations.

The recommendations are chiefly conservative and well founded on established principles. The condemnation of low-dose x-radiation to the ovaries is gratifying. Likewise, the discussion of the psychosomatic aspects of the menopause with the therapeutic emphasis on support and sedation and only in the last resort upon short, tapered courses of estrogens is welcome.

GEORGE W. CORNER, JR.

DIAGNOSIS AND TREATMENT OF MENSTRUAL DISORDERS AND STERILITY. *Third Edition, Revised.*

By Charles Mazer and S. Leon Israel. Paul B. Hoeber, Medical Book Department of Harper & Brothers, New York. $10.00. xiv + 583 pp.; text ill. 1951.

Mazer and Israel's treatise has long ago outgrown the modest claim of the first edition (*Q.R.B.*, 24: 389. 1949) to be "a guide to the family physician." It has become an endocrine bible for the practicing gynecologist. There is now space in it for everything even slightly related to menstrual disorders and sterility, from breast carcinoma to the Rh factor. The forgotten family physician, if he uses the book at all, will undoubtedly read only the therapeutic suggestions. The gynecologist and workers in related fields, on the other hand, will also use it as a reference book to current gynecological endocrine thinking.

In its present incarnation this volume includes considerable controversial material. For instance, many gynecologists will challenge the statement that section of the presacral nerves will cure all but a few cases of dysmenorrhea. Similarly, few biologists or physicists will accept the strong advocacy of low-dose x-radiation to the ovaries as a safe method of stimulating ovulation. This therapy cannot be defended on the basis of the low dose of x-rays involved or the lack of genetic abnormalities in one or two succeeding generations. In the Atomic Age the future of the race will depend as much upon avoiding random cumulative exposure of the gonads to irradiation as upon avoiding atomic war.

The chapters on sterility are good, and the discussion of habitual abortion enhances the value of the book. The equally important problems of premature labor and stillbirth, however, are only briefly touched upon. To devote so small a proportionate part of a book on menstrual disorders and sterility to the problems of fertility is unfortunate. It is as if the glamor of the bizarre nature of some menstrual disorders had blinded the authors to the major purpose of the uterus and ovaries.

GEORGE W. CORNER, JR.

PSYCHOSOMATIC GYNECOLOGY, *Including Problems of Obstetrical Care.*

By William S. Kroger and S. Charles Freed. W. B. Saunders Company, Philadelphia and London. $8.00. xviii + 503 pp. 1951.

Obstetrics and gynecology have now been given the full psychosomatic treatment, an event which their practitioners have been awaiting with mixed emotions. Most of us have long been aware that the psyche and the soma are one and have been doing our feeble best to provide our patients with both somatic and psychic support. This book will be a great help and encouragement to us. There are, however, some of our brethren who will greet this book with disdain. They will feel that the authors have too often fallen into the error mentioned in the book of allowing "the present zeal in attempting to pin the psychosomatic label on various entities" to carry them away. Indeed, some of the assertions in this book are a bit hard to swallow. For example, at the risk of being condemned as an "organistically oriented physician," I must express doubt that maternal emotional instability can produce a blighted or defective ovum which has failed to develop an embryo. Similarly, it is hard to believe that psychosomatic problems contribute very much to the production of uterine fibrosis or fibroids.

The book is a much needed contribution to a rather neglected but fundamental aspect of obstetrics and gynecology. The authors have thoroughly reviewed the literature and their own psychodynamic experience. The discussion of the psychosomatic factors in pregnancy can be read with profit and very little dissent by many obstetricians. It is heartening to find hypnosis in pregnancy and labor considered intelligently and broadly and not as a side-show freak. Natural childbirth is similarly dealt with, minus the evangelism of Grantly Dick Read. Physiologic childbirth, as Kroger points out, is a combination of these two techniques. The chapters on the psychodynamic aspects of common gynecological problems is equally valuable. There is more common sense about abnormalities of the menstrual function here than in many endocrinological treatises.

GEORGE W. CORNER, JR.

IMMUNOLOGY. *Third Edition.*

By Noble Pierce Sherwood. The C. V. Mosby Company, St. Louis. $8.00. 731 pp. + 7 pl.; text ill. 1951.

This third edition is completely revised. Some chapters, particularly the one on flocculation tests used in the diagnosis of syphilis, have been completely rewritten. Discussions of certain new topics, such as (1) blood group factors, (2) the new concept relative to vitamins and the endocrines to resistance, (3) the role of the vertebral veins to metastasis, (4) latent infections, and (5) the mode of viral infection have been included.

TUBERCULOSIS.
By Saul Solomon. Coward-McCann, New York. $3.50. x + 310 pp.; 1952.

The successful control of tuberculosis depends as much on the cooperation of an enlightened public as on the diagnostic and therapeutic regimens of an alert medical profession. As the fears, superstitions, and misconceptions which still surround the disease give way to a better understanding of its nature and manner of spread, as well as of its curability, the hope of its eventual eradication moves nearer to reality. The author's conviction that physicians are better able than anyone else to write on medical subjects for the public is amply attested by this thoroughly readable and completely authentic volume. Written in a most interesting manner and with a minimum of technical terminology, the work covers the history of man's long and tortuous effort to determine the cause and nature of tuberculosis and to devise methods for its control. Of particular interest to the general reader will be the unbiassed discussions of various highly publicized chemical agents, antibiotics, and vaccines which have been used in the diagnosis, treatment, and prevention of tuberculosis. A glossary and a complete index are provided.

B. AUBREY SCHNEIDER

THE WHITE PLAGUE. *Tuberculosis, Man and Society. By Rene and Jean Dubos. Little, Brown & Company, Boston.* $4.00. x + 277 pp. 1952.

The relationships between social trends and diseases throughout the world present one of the most fascinating chapters in the history of medicine. In this carefully prepared and thoroughly documented work the authors have brought into extremely sharp focus the impact of tuberculosis on human society, both past and present; and conversely, the changes in thought and action which were necessary before society could throw off its devastating onslaught.

That the human population has suffered the ravages of tuberculosis for many centuries is amply attested by historical and archeological records. Efforts to explain its cause were of little consequence prior to the formulation of the germ theory of disease, and, because of lack of awareness of the infectious process, the prevalence of the disease increased gradually over the years until it reached serious epidemic proportions during the early days of the Industrial Revolution. In the words of the authors, "Tuberculosis was, in effect, the social disease of the nineteenth century, perhaps the first penalty that capitalistic society had to pay for the ruthless exploitation of labor." The social pressures that had to be overcome before any progress could be made toward control of the disease were enormous. The vast skepticism of the medical profession was surpassed only by the bizarre romanticism of the early Victorian era, which not merely accepted but required, as a mark of fashion in good society, the pallor, the emaciation, the weakness, and even the cough which were indicative of "a consumption."

Social reforms which have been directed against filth and squalor, and toward the provision of improved standards of living through better housing, better water and food supplies, and better medical care have undoubtedly had some effect in reducing the tuberculosis mortality rate. However, lest we rush too quickly to the conclusion that advances in public health have been entirely responsible for the degree of tuberculosis control which has now been attained, the authors hasten to point out that the mortality rates from the disease in the various countries of the world have invariably shown downward trends prior to the institution of any specific public health measures.

B. AUBREY SCHNEIDER

POLIOMYELITIS. *Papers and Discussions Presented at the First International Poliomyelitis Conference. Second Printing.*
Compiled and Edited for the International Poliomyelitis Congress. J. B. Lippincott Company, Philadelphia, London, and Montreal. $5.00. xii + 360 pp. + 1 pl.; text ill. 1949.

This is a record of some 20 papers presented at the First International Poliomyelitis Conference, held in New York in July, 1948. The purpose of the conference was to coordinate and evaluate the progress made in the study of this disease during the past decade. Subjects considered may be grouped as follows: epidemiology (A. B. Sabin, H. J. Seddon, with short reports by a number of delegates from various parts of the world); pathogenesis (I. McQuarrie, D. Bodian, F. Buchthal); clinical management, 9 papers; public health aspects, 3 papers; immunology (I. M. Morgan, J. R. Paul); and experimental chemotherapy (R. N. Bieter, H. N. Wright).

The strong evidence that paralytic poliomyelitis is but one part of the clinical spectrum which can result from infection with the virus suggests that poliomyelitis should be an exceptionally favorable disease for the study of physiological and biochemical factors involved in disease resistance. The admirable studies of the

pathological anatomy and immunology herein reported give us a point of departure for a broader study of systemic factors. Instead, developments since this conference give signs that breaks are beginning to appear in the compartmentalization of thought regarding the reactions between an organism and the poliomyelitis virus.

EVELYN HOWARD

A HANDBOOK OF PSYCHOMATIC MEDICINE *With Particular Reference to Intestinal Disorders.*

By Alfred J. Cantor. The Julian Press, Division of Julian Messner, New York. $5.00. xviii + 302 pp. 1951.†

This book is written by a proctologist, in fact, by the editor of the *American Journal of Proctology.* It is divided into 2 parts, the first half dealing with the basic concepts underlying psychosomatic medicine and offering a composite method of treatment, for which the author makes no claims for originality, and which is borrowed from relaxation methods, psychoanalytic concepts and reeducation, and general semantics. The author calls the method a guided association analysis, intended to get down to "the silent level" of effective expression, deeper than the verbal methods of attack. It is an active intervention, asking the patient actually to relieve traumatic experiences and to repeat the reliving until the experience is no longer procovative of the original feeling but brings only a sense of boredom or monotony. Cantor actually carries on such treatment during the time between the inauguration of spinal anesthesia and the actual operative procedure. He also teaches patients how to do this work on themselves and continue the process in their own homes.

The second part of the book is concerned with the application of these principles to gastro-intestinal disorders—from cardiospasms to hemorrhoids. There is much diagnostic effort employed in this part of the book, and each category and subcategory is illustrated with a case history, brief and to the point, and, leaving the reader, whether on purpose or not, with the impression that the methods employed are quite successful in the handling of any and all gastro-intestinal conditions. From time to time, Cantor casually states that the patient could or might better be referred to the psychiatrist.

It may be assumed that the author out of a large experience must be convinced of the workability of his methods, and indeed I believe that they might be appreciated by a large segment of practitioners in the gastro-intestinal field. As a psychiatrist dealing with psychosomatic problems also, I can only be impressed with the general conclusion that the case histories offered present a simplified version of the difficulties to be encountered in actually changing human attitudes. The effect of traumatic experiences cannot be denied, but long experience also shows that it is not just one or two traumatic experiences but a whole multitude of experiences, some not even immediately recognized as traumatic, which go to make up the basic attitudes of individuals to the lives they ask themselves to lead. It takes time and a good working relationship with the physician. One other point which leaves me a little bit uneasy is the author's insistence that the physician must show every confidence that the patient is going to get well. This kind of authoritative attitude undoubtedly has its good points, particularly for short-term treatment, but has very definite drawbacks, particularly for the more intractable cases. Furthermore, how any physician can subscribe to hollow optimism and confidence is a bit difficult to understand. Modern psychiatry rests on a basis of collaboration between the patient and the physician on the problem rather than upon authority.

WENDELL MUNCIE

ARE YOUR TROUBLES PSYCHOSOMATIC?

By J. A. Winter. Julian Messner, New York. $3.50. x + 222 pp. 1952.

Over the centuries, as each of the great problems in medicine has been solved, it has become necessary to make the layman—or, shall we say the patient—aware of new facts. The certainty of his awareness of some of these new facts and concepts was essential if he was to help the medical practitioner to the fullest extent in the prevention or cure of his illness.

Almost every time a new concept of disease arose, it met with the most stubborn of emotional, irrational opponents—fear—and consequently with disbelief. When the germ theory was introduced, the layman (and the doctor as well!) would not believe in the presence of little animals he couldn't see, and it was only very slowly that there developed an acceptance of things which today are common places for all of us. However, in the last 20 to 25 years, a new concept has arisen which finds itself confronted by even greater emotional resistance, since it is so much more closely tied to the emotions themselves. Only very recently have people begun to accept the idea that asking for the help of a psychiatrist is intelligent and without shame —no different, in fact, from a visit to any other practitioner of medicine when some part of the organism other than the brain has temporarily gotten off the track. The time has now arrived for the patient to understand still another method of treating disease—a method which, since it relates to both "mind" and "body" has come to be called "psychosomatic." It is only to be expected that this concept will meet with great emotional resistance until patients have been made fully aware of its bases, and through removal of the emotional (much more than the intellectual) barriers, have

come to see and accept its therapeutic value. It is difficult to bring about general understanding of the thesis that many types of organic disease, which all of us "know" can be and are caused by purely organic disorders, can be imitated completely by psychological etiological factors alone. It is even more difficult to go the next step, to understand what Winter calls "a sort of paradox—the paradox that people mistakenly seek to solve the problems of existence and survival by becoming ill."

Thus it is that Winter has attempted to explain in simple terms many of the medical problems which the doctor is now learning to think about as psychosomatic. He discusses some of the psychological concepts involved, proceeds to the role of emotional factors in sexual problems, allergies, ulcers, and a host of other disease processes, and concludes with discussions of communication (the "language of emotion") and self-awareness in helping people to deal with their own problems. (I have some tendency to doubt the value of this last.)

Any such undertaking is bound to be unevenly presented, and this is no exception. Some of the most cogent statements can be found in the brief Preface, which, unfortunately, many readers have a habit of neglecting. The author would have been wise to repeat quite clearly at the end of the book, for example, the remark that "We propose to give you an idea of psychosomatic disease in order that you will be able to suspect it and then to consult one who is trained to recognize it and to treat it in the most effectual way." It is that purpose which gives to a book of this nature its importance and value, and from time to time the author touches on ideas which contribute to the attainment of his goal. However, nowhere has he dealt consistently and in any detail with the emotional factors which prevent one from becoming aware of the psychosomatic nature of one's own ailment. To be sure, relieving an anxiety of which the patient is conscious may be a major part of relieving his organic complaints, but what of the anxieties of which he is completely unaware? In other words, the book as a whole would have been enhanced by some further clarification for the patient of the role and techniques of psychotherapy—this discussion being substituted for some of the brief case histories which have too great a tendency to simplify very complex pictures.

Space does not warrant any more detailed criticism or discussion of the author's choice of material and method of exposition. Suffice it to say that the book presents a mixed picture, but that on the whole it is an attempt which should do more good than harm, in a field where efforts like this are very valuable and sorely needed. Readers who are unfamiliar with this field will gain a certain insight into their problems, and perhaps a hope that they now do not have.

ROBERT G. GRENELL

THE BIOLOGY OF MENTAL HEALTH AND DISEASE. *The Twenty-seventh Annual Conference of the Milbank Memorial Fund.*

Foreword by Stanley Cobb; 108 contributors. Paul B. Hoeber, Medical Book Department of Harper and Brothers, New York. $10.00. xxv + 654 pp.; ill. 1952.

One of the developments in modern sciences has been (perforce?) the realization that successful research appears to be more and more frequently the result of cooperation on the part of many workers in many special fields and with many specialized talents and points of view. With the increase in frequency of this basic approach, there has come the realization that to reach the desired goal all the varied experimental attacks, points of view, etc., must be brought together, correlated and integrated, and an interpretation made from a careful digest of the whole. Consequently, symposia have become more and more frequent, in the hope that they would help with the presentation and integration of the data—some have succeeded and some have not. The present volume demonstrates one of the best efforts to date to accomplish a herculean task. Representatives of all disciplines bearing upon the biology of mental health and disease have presented their techniques, data, and concepts, and have made a magnificent attempt to "promote the organization of all the material as a preparatory step toward its integration."

Of the principal speakers, 10 were chemists, 6 were physiologists, 5 psychiatrists, 4 neuropathologists, 3 anatomists, 3 psychologists, 2 geneticists, and 1 internist, 1 epidemiologist, and 1 electroencephalographer. All of these were primarily interested in laboratory investigation. Their discussions fall into two large categories, the biology of normal mental activity and that of mental disorders and deficiencies. Attention was given to cerebral structure (histologic and chemical), transport (vascular problems and the blood-brain barrier), metabolism and function (oxidations, enzyme systems, electrical and chemical manifestations of activity), patterns of localization, organic disease and genetics, induced experimental disorders and abnormal reactions, and mental deficiencies. It is obvious that a remarkably wide range of material is presented, ranging from chemical properties of an individual neuron to abnormality of the whole brain.

It becomes apparent, among other things, from such an assembly and organization of biological data, that many of the problems of mental disease—which is to say, some of the major problems of psychiatry today—are not to be solved by studying the disease process itself! The answers will come, one hopes and feels, from the sort of integration presented in this symposium. As our knowledge of the properties and reactions of a neuron increases, so will our ability to interpret the more complex patterns of the interrelationships of groups of neurons. Then only will we be able to make an attempt to understand how these processes are altered to give

the picture of mental disease. In other words, we must identify cellular components, locate them in space, examine the dynamics of their life history in the cell (their precursors and degradation products and their relationships to enzymes, etc., as well as their changes seen with many techniques, electrical and chemical), and interrelate metabolism and functional activity. The next steps are those of the study of integrated behavior of neuron groups, and finally the problems of abnormality. As Ralph Gerard states in his discussion, "The walls of understanding of cellular organization and of brain function and mental behavior are all growing, and . . . leaning toward closure very rapidly indeed." Symposia such as this are certainly effective in helping this process.

ROBERT G. GRENELL

GENERAL THEORY OF NEUROSES. *Twenty-two Lectures on the Biology, Psychoanalysis and Psychohygiene of Psychosomatic Disorders.*

By Rudolf Brun; translated by Bernard Miall. International Universities Press, New York. $10.00. viii + 469 pp. + 3 pl. 1951.

This book is a translation of the second revised edition (1946) of a work the first edition of which appeared in 1942 in Switzerland. It is part of a 7-volume series on Mental Hygiene, Theory and Practice. This particular orientation of the book, and the fact that it is based on lectures which the author gave in the University of Zürich before an audience of physicians and students may account for its occasional repetitiousness and the frequent dwelling on facts which must be considered basic psychiatric knowledge. The author himself regrets that the special aim of his book prevented him from "entering more closely into the philosophical and metaphysical questions."

The special interest of the book lies in its attempt to give a "synthetic representation" of the psychological and physiological aspects of the neuroses, and to "incorporate the results of psychoanalytical research organically in the theory of the neuroses." Throughout the text the formulations of classical psychoanalysis (with the exception of the concept of the Death Instinct) are expounded and defended against criticism. Indeed, Freud's "metapsychological" studies are termed "psychobiological." Rudolf Brun, who is Professor of Neurology and Neurobiology at the University of Zürich and a pupil of C. von Monakow, gives a comprehensive exposition of the physiology and pathology of the midbrain, and discusses critically their possibility as organic factors in the etiology and symptomatology of the neuroses. He includes the neuroses in "a great pathological group of the primary disorders of the instinctive life," the "hormopathies." Following early concepts of psychoanalysis, Brun distinguishes between actual neuroses and "psychoneuroses in the narrower sense" (or "vegetative" and "conversion neuroses," respectively). The first group iucludes neurasthenia, anxiety neuroses, and "fright neuroses." These he calls functional organic [sic!] (toxic) hormopathies, and assumes that they are produced by a direct mechanical or toxic disturbance in the region of the vegetative cerebral centers. "They really do not appear to be psychically determined; they have no psychological significance." Brun is of the opinion that the "plexus theory" (of C. von Monakow) completely explains the origin of these affections as well as their symptoms. With the psychoneuroses it is different. "Here, Monakow's theory cannot do much more than provide the hitherto somewhat mystical conception of the constitutional predisposition with a solid morpho-physiological basis." Such as "individual predisposition always plays an essential part in the contraction of an actual neurosis. . . . It is also of decisive importance as regards the progress and issue of the neurosis, inasmuch as individuals in whom the hemo-encephalic barrier and neuro-vegetative system were previously intact recover more rapidly—and are less liable to lapse into a chronic stage." Such a predisposition, however, plays a certain role also in the psychoneuroses. "We are obliged to assume the existence of such morphophysiological predispositions as regards the primary symptoms of the psychoneuroses. . . . Among these are: enhanced tendency to repression and affective conversion, the remarkable aptitude of converting repressed affects into physical innervation processes, the primary affective ambivalence of the obsessional patient . . . the primary increased preparedness for anxiety and so forth." In psychotherapy this predisposition, too, is a factor to be considered. The core of the personality is ultimately based on the constitutional instinctual disposition, which everyone brings into the world as his inheritance. It is nonetheless possible, however, "by bathypsychological methods, very largely to influence the embiontic consequences of this inheritance and to prevent, permanently, such unfavorable effects as would lead to the development of neuroses." In a glossary, which concludes the book, the author defines the term "embiontic" as meaning: acquired in life.

WALTER O. JAHRREISS

THE NEUROSES. *Diagnosis and Management of Functional Disorders and Minor Psychoses.*

By Walter C. Alvarez. W. B. Saunders Co., Philadelphia and London. $10.00. x + 667 pp. 1951.

The Senior Consultant Emeritus in Medicine of the Mayo Clinic has attempted to organize, according to his prefatory statement, the best of what he has "been able to glean during forty-five years of busy practice" about the recognition, diagnosis, and treatment of

"nervous, neurotic, or slightly psychotic persons," and "the many functional syndromes from which they tend to suffer." He writes as a fellow non-psychiatrist for those non-psychiatrist physicians who are constantly confronted by the problems posed by such patients. The book is divided into 6 parts: Introduction, Diagnosis, Causes of Neuroses and Psychoses, Types of Personality and Several Syndromes, Psychosomatic Features of the Several Specialties, and Treatment. The work merits both high praise and severe criticism.

The 2 chapters dealing with surgery can be considered as required reading for all physicians, psychiatrists and non-psychiatrists alike. Emphasis is placed upon the fact that the patient with a borderline psychosis, instead of receiving psychiatric treatment, is instead subjected to multiple surgery. The chapters on the Ordering or Not Ordering of Tests and the Disregarding of Findings that have Nothing to do with the Case merit reprinting by themselves for reading by medical students and internes, for they emphasize wholesomely that it is on the basis of the history that the diagnosis can be made; that money should not be wasted on needless tests; that questionable laboratory reports must be repeated and checked; and that laboratory reports, even from good laboratories, "can be wrong," because technicians may occasionally be untrained, because mistakes may creep in during the copying of records, or because findings may be affected, especially at first, by the patient's emotions at the time they are taken. The material in these chapters is documented. Stress is again and again placed on the fact that nothing can take the place of a good history, and that no test exists that of itself will make it possible for the diagnostician to state that "the woman sitting on the other side of the desk is . . . dying of a broken heart, or is ill because she lies awake every night listening to the breathing of an asthmatic or epileptic child. . . ." The book is full of a great deal of common-sense advice for the recognition and handling, by the general practitioner as well as by his colleague in the individual specialties, of those patients with whom he comes in daily contact during his practice. It can be highly recommended on this score.

On the other hand, there are a number of glaring defects in the book. The author shows little knowledge of dynamics; he places his sole emphasis on recent stress and strain as the etiologic rather than the precipitating factor in the appearance of emotional disease; and, for the most part, he lists as causes of emotional maladjustment what most psychiatrists would consider to be symptoms. He stresses what he terms "poor nervous heredity," not only in a full chapter devoted to the subject, but on page after page throughout the book, leaning heavily on the long since disproved pseudoscience of Goddard and others. He confuses biological with possible cultural inheritance, and apparently believes that promiscuity, epilepsy, impotence, frigidity, alcoholism, bed-wetting, a violent temper, neuroses, and psychoses are apparently interchangeable evidence of a "poor nervous heredity," any or all of which may appear among the relatives of a patient under treatment.

This criticism, however, is relatively minor. In his many hints about treatment, as well as in the chapter devoted to it, Alvarez makes a number of commonsense suggestions of value to the non-psychiatrist in his contact with patients. Although the recommendation is made frequently that specific patients should be referred to a psychiatrist for treatment, nevertheless, if one can judge by the illustrative case material, the non-psychiatric physician who reads this book will in all likelihood attempt to treat with minor techniques those patients who really need what (for want of a better term) could best be called major psychotherapy. It is necessary for us to know and to recognize our treatment limitations, and a section could well be added to the book on this topic.

To summarize: this book was written by a non-psychiatrist, with deep feeling for his patients, for non-psychiatrists. Some sections are outstanding. Others show what to the psychiatrist, in the light of the knowledge of the past few decades, seem glaring defects. I would suggest, therefore, that the second edition of this book be prepared in collaboration with a psychiatrist.

HAROLD ROSEN

HYPNOIDAL PSYCHOTHERAPY.

By Margaret Steger; foreword by Frederic Bergstrom. Froben Press, New York. $3.50. 150 pp. 1951.

This is a well written and readable book by an author who seems completely unacquainted with any of the significant clinical investigations in the field of hypnotherapy during the past 20 years.

By the term "hypnoidal psychotherapy," Margaret Steger means the psychiatric treatment of patients while in the hypnoidal state, with insight to be attained by the patient on the basis of explanation and suggestions made by the therapist, primarily on the basis of the latter's knowledge of patient's problems and the motivational bases for his behavior. She uses the term "hypnoidal state" to refer to what most authorities today would prefer to call light hypnosis, but nevertheless devotes 3 of the 9 chapters of the book to an attempt to differentiate between the hypnoidal and hypnotic states, and adds paragraph after paragraph throughout the rest of the book in an unsuccessful attempt to emphasize this difference. For instance, according to her, ". . . hypnosis should be regarded as an *abnormal* mental state, whereas the hypnoidal state is a *normal* mental state," as a result of which ". . . hypnotic suggestions . . . promote emotional conflict, whereas the effect of hypnoidal suggestions is to dissolve such conflict" (p. 71). Despite the author's belief to the contrary, it seems obvious that it is the type of suggestion made, and not whether

it be made to a patient under light or deep hypnosis, that should be taken into consideration. Along with misconceptions of this type are frequent misstatements of fact like the following: "While the hypno-analytic procedure brings out deep-lying psychic material, the patient remains unaware of it and [it] therefore . . . must subsequently be communicated to him in appropriate form. The conscious . . . co-operation of the patient in the producing of preconscious fantasies and associations will not be activated during hypno-analysis" (p. 97). This statement runs counter to practically all clinical research on hypnosis and hypnotherapy since 1933 and shows the author quite unfamiliar with the contents of Wolberg's *Hypnoanalysis* (1945), the only work dealing with clinical aspects of the subject and published since 1914 which the author includes in her bibliography. This is emphasized by her categorical statement to the effect that "a schizophrenic state also prohibits the use of hypnosis on account of possible injurious consequences" (p. 108) and ". . . severe psychotic cases . . . are not accessible to psychotherapy," although in Wolberg's book the first 144 pages are devoted to a session by session description of the hypno-analytic treatment of an institutionalized schizophrenic patient.

A few sections can be read with profit. These include the paragraphs on the dangers of hypnosis, the necessity for so preparing the patient that suggestions, when given, will fall on fertile ground, and parts of the chapter on alcoholism. We should especially like to stress Margaret Steger's statement that "although we must recognize that alcoholism is a disease, we have to prevent the alcoholic from using this concept as a weapon in his defense."

Nevertheless, and despite the introductory statement to the effect that this book "should be of interest to students, practitioners of medicine and even to psychiatrists themselves," it cannot be recommended for reading either by a psychiatric or a non-psychiatric audience. Too many misconceptions are promulgated and too many apparently factual statements are either controversial or actually contrary to fact.

HAROLD ROSEN

SYMBOLIC REALIZATION. *A New Method of Psychotherapy Applied to a Case of Schizophrenia. Monograph Series on Schizophrenia No. 2.*

By M. A. Sechehaye; translated from the French by Barbro Würsten and Helmut Würsten. International Universities Press, New York. $3.25. 184 pp.; ill. 1951.

This is a remarkable account of the treatment at the hands of a lay analyst, I gather, of a serious case of schizophrenia, so diagnosed by any number of very reputable psychiatrists. The treatment extended from about the years of 18 to 26. The case history is remarkable for the fact that the author developed methods of interpreting the patient's magic thought processes and developing devices through the use of symbols, by which the patient was able to realize long-frustrated primitive desires and ambitions. The author has been able to show that the patient's difficulties began at a time before normal language development takes place, that her schizophrenic material was a direct throwback to the prelogical thinking era, and that her primitive desires had to do with such vital things as the right to live, the right to eat, the right to her share of love in the family, and so on. The historical account actually showed that the patient had been victim of the most severe emotional deprivations at the hands of her mother and father, which had not served, however, to dim her intellectual functioning. With an abundance of affection, with an expenditure of a very great deal of time, and most of all with the intuitive understanding of the step-by-step expression of the patient's developing needs from one level of development to another, and by devising symbolic means for the irrealization and gratification, the patient was gradually brought back from such infantile demands to acceptable social expressions of the same needs at a mature level. Sechehaye shows also rather convincingly that all the other adjuvant treatments were of no avail, except the use of sedatives in the patient's more excited periods. The shock therapies were not tried, because they were not in current use at the time when the treatment began.

It is notable that the author not only was sympathetic and affectionate but was authoritative, and used her role as mother substitute in an authoritative way to build up the patient's ego. She even did not hesitate to make use of magic formulas herself to counteract the patient's destructive ones. That the patient was able to accept the author's authority bears testimony to the rapport between them. This, described as a new treatment in schizophrenia, is a new and thrilling experience to read about. With the documentation given, it should be possible to expand such material in the hands of others and so to learn to what extent a method like this can be taught and applied.

In the translation from the French, the word "delirium" is used instead of "delusion." It was confusing to read about the patient's "delirium" when what she actually suffered from seems to have been a confused delusional state. The girl was variously diagnosed as in catatonic and hebephrenic states, but she ended up doing brilliant postgraduate work in biology in the University, and has remained well now for some seven years. The psychiatric world is deeply indebted to Madame Sechehaye for a factual account of an extraordinary experience which very few people can duplicate in any sense.

WENDELL MUNCIE

REALITY AND DREAM. *Psychotherapy of a Plains Indian.*

By George Devereux; prefaces by Karl A. Menninger and Robert H. Lowie; psychological tests edited and interpreted by Robert R. Holt. International Universities Press, New York. $7.50. xxvi + 438 pp. + 12 pl. 1951.

This is an exceedingly interesting book, which sets out to do just what the subtitle indicates, namely, to present the psychotherapy of a Plains Indian (tribe not better identified for purposes of protection) who suffered from a rather severe psychoneurotic development. He was a patient at the Winter Veterans Administration Hospital in Topeka, and the author, an ethnologist and anthropologist, conducted the treatment by permission of the medical authorities. The book actually is devoted to a presentation of the interconnections between neurotic symptom formation and the culture in which the neurotic development occurred. This is the first presentation of any consequence dealing with this subject as regards the Plains Indian. The actual psychotherapy proceeded by active counselling, and presented in general the same mechanisms and procedures as would be noted in work with any such patient. The valuable part is the constant reference to the Indian culture, without which information the therapist might have badly gone astray. Devereux, steeped in Plains Indian lore, history, and psychiatry, proved himself to be alert at every turn to this issue, quickly established good rapport with the patient, and through his friendly, sympathetic attitude and incisive interpretations, was able to assist the patient to a very real measure of recovery within a short while. He returned to his Indian civilization better adjusted and with a happier outlook. (He also lost his job some time after leaving the Hospital, and applied to Dr. Devereux for some financial aid. Dr. Devereux does not say whether or not he lent him the money. Perhaps this should not be stressed as a criterion of the doctor's judgment of the patient's improved status.)

There are interesting prefaces by Karl Menninger and the well-known anthropologist, Robert H. Lowie, himself a Plains Indian expert. The preliminary parts of the book, those dealing with the essential factors in psychology of the Plains Indian, and particularly those items dealing with prestige values and the heterosexual relationships in the broader sense, prove to be the most interesting parts of the book. Admiration is evoked by Dr. Devereux's adept handling of the case, and by the very real degree of improvement in the patient which he seems to have attained in a short while. As a project more or less sponsored by the Veterans Administration, this book is a tribute to a research interest of far-reaching import and does credit to the central office of the Veterans Administration as well as to the local talent.

WENDELL MUNCIE

AN INTRODUCTION TO GROUP THERAPY.

By S. R. Slavson. International Universities Press, New York. $3.50. xvi + 352 pp. 1952.

This is a report on a Group Therapy project undertaken by the Jewish Board of Guardians in New York City, and beginning in 1934. The material is based on 750 children divided into 55 groups, each group being studied for approximately 2 years.

This is a very interesting volume indeed, and a number of very important items, crucial for the practice of group therapy, have come out of this very considerable experience: matters dealing with the choice of clientele, the principles determining the size and composition of groups, the functions of the supervising adult, the therapeutic import of the group activity. Throughout the book there are extracts of actual case material to illustrate points at issue, and finally 5 cases are reported at length. The groups are commonly limited to 5 or 6 children, being kept small because it was found that "therapists cannot act in *loco parentis* to a larger number." Any one group was distributed over a 2-year age span but the consideration of age frequently had to give way to issues of emotional and social development as more important. Incorrect grouping resulted in undesirable behavior. The therapist had to be very careful not to single out an individual for special attention, particularly in an effort to protect sensitive and introverted members against the more rough and extroverted ones. Too many aggressive children in one group seemed to reinforce each others' unhappy trends. Girls expressed their aggression orally; boys by physical combat. Groups consisting of entirely withdrawn and self-effacing children proved ineffectual for therapy, and such groups had to be infiltrated with more active and aggressive children. Intragroup balance was therefore found to be very important. The groups were confined to a single sex, except for some tentative experiments with mixed groups in the younger years. Shifts from one group to another were made in a deliberate effort to increase the children's opportunity for adaptation. Small subgroups tended to appear within the group. The intelligence quotient scatter seemed to be a relatively unimportant criterion in grouping maladjusted children; manual skills likewise seemed unimportant. "The most important of all considerations in grouping children is to prevent them from re-living in the group the traumatic relations and the problem-producing atmosphere of the home and the school. . . . The further traumatization of children in the group that repeats earlier patterns can be prevented by detailed information on the character structure of the child, the social pathology of the home, school, and other relations, and a thoughtful matching of these against the personalities and backgrounds of the other members in the group. . . . With some exceptions, Group Therapy aims to substitute pleasant for unpleasant experiences and to compensate the child for

his earlier sufferings. If we fail in this, we fail in our chief objective."

The group therapist must be sensitive to himself and to his own feelings and to the feelings and needs of others; fundamentally unhostile; of few words and of good judgment in the use of language; of a placid temperament; positive rather than cynical or destructive in his approach to life; objective toward his charges; possessed of psychological insight; able to meet unusual problems and resourceful in devising psychological and physical conditions to cope with difficult situations; handy with tools and the crafts; receptive to suggestions, emotionally responsive, intellectually hospitable, and not on the defensive. "There is no room in Group Therapy for the compulsive, the paranoidal, the rigid, or the moralistic." The therapeutic process is aimed at the reduction of anxiety, the release of energy through activity, the development of self-acceptance and the acceptance of others, and the capacity to adjust to an expanding environment; also to the overcoming of feelings of sexual inadequacy; an increase of frustration tolerance, development of a group superego, and in general the maturity of the personality. From the results cited in this book, it may be said that the material, all of them maladjusted children, shows these objectives can in part or in whole be reached through group therapy at the hands of serious and capable workers in the field.

This should be a very valuable book not only for psychiatrists and particularly those interested in group therapy, but I think there is material here also of great interest to school teachers, scout masters, playground directors, and others who deal directly with children in groups. The methods could be carried over bodily into such work, while the approach to the problem and the insights attained, as noted in this book, would lead to the general enhancement of an understanding of children, the normal as well as the maladjusted.

WENDELL MUNCIE

MENTAL HYGIENE AND LIFE.

By Louis Kaplan and Denis Baron; illustrations by Barbara Kirsch Hamilton. Harper & Brothers, New York. $3.50. xvi + 422 pp.; ill. 1952.

This is a textbook for a college course in mental hygiene and as such it has many assets. The style of writing is excellent, the line-drawing illustrations are generally pertinent and have clear meaning. The bibliographies at the ends of chapters are not only comprehensive, but are particularly useful in that one is told what help he may get from a particular reference.

The book deals primarily with the mental side of mental health, and this introduces certain biases that will arouse criticism from biologically or medically trained readers. For example, it appears unwise to speak of the whole load of mental illness that society bears as an evidence of the need to think of mental hygiene and then to discuss only the presumed psychogenic disorders in the book, whereas a considerable part of all mental illness originates in brain damage by trauma and disease. One of the authors is a clinician. Presumably he deals with a medically screened case load, so that he has not been impressed with behavior disturbances which have somatic defects as one of the etiological factors.

The discussion of the mental mechanisms is probably the best section of the book. The section on personality development is rather weak and is too condensed. It bears the general fault of the book, the neglect of the somatic side of development and particularly of the maturation of the nervous system. Unfortunately, these topics are not well represented in the bibliography either, so that students' attention would not be called to them in a course based exclusively on this book. While the authors use a Freudian structure for their psychodynamics, the book calls upon many points of view and may be said to be eclectic.

PAUL V. LEMKAU

THE COLLECTED PAPERS OF ADOLF MEYER. *Volume IV. Mental Hygiene.*

General Editor, Eunice E. Winters; with an introduction by Alexander H. Leighton. The Johns Hopkins Press, Baltimore. Four Volume Set. $30.00. xxviii + 557 pp. + 2 folding maps; ill. 1952.

This final volume (Vol. III, *Q. R. B.*, 27: 380, 1952) of Meyer's papers deals with mental hygiene and contains some 60 papers and book reviews, grouped under the following headings: Ideals for Work in Mental Hospitals; Psychiatry and the Law; Psychiatry and the Community; Aftercare and Social Work; The Mental Hygiene Movement; Eugenics; Psychiatry and the Child; Psychiatry and the Problems of Maturity. Here will be found a refutation of Patrick Mullahy's criticism of the Meyerian approach for its alleged failure to take into account the social consequences of personality (see Mullahy's review of Alfred Lief's *The Common Sense Psychiatry of Adolf Meyer*, in the *Saturday Review of Literature*, 1951.) A brief review of the papers included under the head of Psychiatry and the the Problems of Maturity, for instance, will disclose a range of interests, each one of which is of very considerable importance to psychiatry as a discipline and to the cohesive forces of society, e.g., Discontent—A Psychobiological Problem of Hygiene; Normal and Abnormal Repression; Freedom and Discipline; The Meaning of Maturity; Alcohol as a Psychiatric Problem; Spontaneity; Respect of Self-and-Others and Equity for Peace; etc. To my surprise, I find in the "Discontent" paper

noted above (and never before published), an exact duplicate of the psychological attack on the problem of neurasthenia which I made in 1940. Strangely enough, although Meyer was well aware of the content of my own paper, he never made any mention of his own paper on Discontent as a precursor to it. I take this opportunity to cite my obligation. I must have received from him, unknown to myself, the basis for the approach I made to the problem. This little incident undoubtedly stands at the center of the experience most trainees had with Adolf Meyer. We received such a liberal education in the problems of psychiatry, with roots leading back to so many other disciplines in which he was more than an interested amateur, that when we settled down to our own problems we were quite unaware of our total debt to him.

A good bit of the earlier material concerned with mental hospitals in the present volume was written at the time when those hospitals were much less accepted than they are today. Nevertheless, the points of view expressed here are still pertinent.

Alexander Leighton, Professor of Anthropology at Cornell University, who was the last Chief Resident under Dr. Meyer's regime at the Phipps Psychiatric Clinic, has written a personal appreciation of him which should help to correct much misunderstanding concerning his point of view. This Preface should be read first by those who are not well acquainted with Adolf Meyer's style of writing.

This volume completes the collected papers. In looking over the entire set of volumes, one must consider that the job has been very well done. It is a most worthwhile contribution to modern psychiatry, and this particular volume suffers none in comparison with the first three in editorial aspects.

WENDELL MUNCIE

RARE MANIFESTATIONS OF METABOLIC BONE DISEASE. *Their Practical Importance.*

By I. Snapper. Charles C Thomas, Springfield, Ill. $3.00. v + 93 pp.; ill. 1952.

The Beaumont Lecture delivered by the author before the Wayne County Medical Society is presented as a monograph in this small book. It consists of 5 chapters and a bibliography. The first chapter presents concisely and clearly the current concepts of osteogenesis, calcium metabolism, and the mechanisms by which several metabolic diseases affect the skeleton. The second chapter is on hyperparathyroidism, and not only reports the skeletal affections of this disease but demonstrates the existence of hyperparathyroid disease without skeletal changes. In the third chapter, multiple myeloma is discussed, and evidence is adduced that this disease may be present with no skeletal changes. The next chapter considers changes in blood calcium in diseases other than those previously considered. The final chapter is essentially a summary. The lecture is well organized and interestingly presented.

I. WM. NACHLAS

TOXICOLOGY OF URANIUM. *Survey and Collected Papers. National Nuclear Energy Series, Manhattan Project Technical Section. Division IV—Plutonium Project Record, Vol. 23.*

Edited by Albert Tannenbaum. McGraw-Hill Book Co., New York, Toronto, and London. $3.00. xxvi + 333 pp.; ill. 1951.

The National Nuclear Energy Series comprises a record of the scientific contributions and activities accomplished under the Manhattan Project and the Atomic Energy Commission in the utilization of atomic energy for military purposes. Division IV of this Series concerns the Plutonium Project and out of the declassified material pertaining to health under this division, the contents of this Volume 23 are being published in order to cover that portion called the *Toxicology of Uranium*. The book comprises a survey of the records and results as well as 16 collected papers. The survey chapters describe uranium poisoning from almost every aspect, including a chapter on the Mechanism of Action of Uranium, by Guzman Barron. Details of these same subjects are taken up in the various papers.

The book is chiefly a reference volume, and as such is well documented and contains numerous graphs and much data. It is a signal contribution to our knowledge in this field, and much credit is due to the authors and editors for the large amount of work which production of the book must have required.

FREDERICK W. BARNES, JR.

PSYCHOLOGY AND ANIMAL BEHAVIOR

AN INTRODUCTION TO PSYCHOLOGY.

By Gardner Murphy, with the assistance of Herbert Spohn. Harper & Bros., New York. $4.25. xx + 583 pp. + 6 pl.; text ill. 1951.

Beginning with chapters on genetics and on the nervous and endocrine systems, and closing with chapters on culture, the scope of this textbook for the elementary college course in psychology is perhaps the broadest in any textbook today. Nor is the range of topics strung together loosely like beads on a string. The concept of personality is used as a focus to organize and discuss the usual themes of general psychology, current data connected with the self-concept, methods for personality study, and effects of social and cultural influence. "... The emphasis here is on the *wholeness of the individual: the psychology of the individual person.*"

It is characteristic of Gardner Murphy's writing that it usually communicates his keen interest in persons, as well as his enthusiasm for a variety of approaches to their study. He has accomplished this again in the present text, unusual for its clear, direct language, and the use of case study and autobiographical materials. Further enhancing its value and appearance are a generous number of relevant illustrations, diagrams, and tables, many of which are in color. An accompanying manual of experiments and projects that parallel the content of various chapters of the book will provide additional substance of interest to student users.

This introductory psychology textbook comes closer than any other to what the usual student is looking for when he enrolls for the general course. Murphy's book deserves a trial by every teacher who is challenged by the variety and freshness of questions that students bring with them to the introductory psychology course.

ERLING W. ENG

THE PSYCHOLOGY OF THINKING.

By W. Edgar Vinacke. McGraw-Hill Book Company, New York, Toronto, and London. $5.50. xiii + 392 pp.; ill. 1952.

The need for a textbook in the field of thinking has been obvious for some time. The nature of thought is a central problem for psychologists, and students are typically interested in it. And yet it has been difficult to treat this material in undergraduate courses because of the lack of ready references suitable for students. Vinacke's book helps to fill this gap.

The fact that the gap is not completely filled is more the result of stylistic failures than of any weakness of scholarship or any neglect of the topics that might belong in a course on thinking. The reader often feels that a piece of information has been included only because nothing better was at hand, rather than because the author's expository plan demanded that fact at that place. Despite an almost too apparent effort at classification, outlining, and organizing—all the mechanics of construction—the book never achieves much unity or force or sense of direction. It is hard to tell for whom Vinacke is writing. It is hard to tell what he thinks is important in all this fact-collecting. It is hard to tell what he thinks researchers in these fields should do next. It is never possible to anticipate the content of the next chapter.

This is a rather good series of review articles for undergraduates on a wide variety of different topics, all of which have some legitimate relation to what we mean by thinking. Some of the individual chapters are excellent, and most of the omissions are minor. An exception may be made of the chapter on the Mechanism of Thinking—a chapter which struck this reviewer as extremely weak. Pages are devoted here to an ancient controversy about the presence of muscular activity during ideation, but nowhere is there mention of the speculations of Hebb or of McCulloch, and nowhere is there any indication that the great literature on brain pathology might be relevant.

Teachers of psychology will be properly grateful for a book that contains summaries of so much work that has not before been gathered in one place. The problem of finding sound reading matter for courses in cognition is now greatly eased. The book will be especially valuable for looking up individual topics, and mechanical matters like citations, indexing, and bibliographies are very carefully done, so that such use will be facilitated. There is not much stylistic lightness in the book, and the student will probably find the dissertation-style dull and difficult. All in all, this is a better classroom reference book than textbook; but it will serve as a textbook till a better one comes along.

W. C. H. PRENTICE

PSYCHOLOGY IN INDUSTRY.

By J. Stanley Gray. McGraw-Hill Book Company: New York, Toronto, and London. $5.00. viii + 401 pp.; ill. 1952.

This book contains an interesting and practical analysis of the psychology of the individual workman. Its main theses centers around the survey of the more important factors which affect workmen and their efficiency at work. Of special interest is the fact that factors affecting worker efficiency which are not usually discussed in presentations of this sort are included.

A pointed and concise discussion of basic concepts with respect to the amount, measurement, and efficiency of work, and the fatigue resulting from work introduces the reader to an understanding of the more recent developments in this field. The techniques of job analysis and worker analysis are subsequently surveyed, and the basic principles of learning and the patterns useful for training workers, supervisors, executives, and specialists are briefly outlined. A few of the more direct procedures used in industrial plants as well as the procedures used in the stop-watch time study are discussed, the latter requiring less training and ability than is required for making the motion-analysis studies. Methods of remuneration, worker evaluation, and job evaluation are skilfully outlined. Effects of nutrition and rest, safety, monotony and boredom, and lighting and ventilation on worker efficiency are surveyed at some length. Finally, in the last 3 chapters the age factor, the worker's morale, and the employee's adjustment are ably analyzed by Karl Garrison.

The merits of the book lie partly in the fact that the treatment of the various topics throughout the volume

is factual rather than theoretical. Discussion is based on the findings of representative samples of research, illustrated by numerous tables and graphs. Several factors which affect worker's efficiency are not included because adequate research is lacking to substantiate discussion. Additional information on various subjects in industrial psychology is made available in the recommended references to be found at the end of each chapter.

DANIEL D. DAY

GRUNDFRAGEN DER TIERPSYCHOLOGIE. *Ordnungs- und Gestaltprobleme.*

By Hans M. Peters. Ferdinand Enke Verlag, Stuttgart. DM 17.— (paper). viii + 120 pp. + 2 pl.; text ill. 1948.

This book is a real disappointment when its title is taken as indicative of the book's actual coverage. The disappointment is probably heightened by the fact that we have today a need for a thorough statement of the "Basic Problems of Animal Psychology." What the author has actually done is to present a summary of two of his research problems. The first deals with an account of the founding of animal families. Distinctions are made between "parent families," "mother families," and "father families." The experimental evidence comes mostly from fishes, but some comparison is made with reptiles and birds. There are incidental observations of innate releasing mechanisms, in the Lorenz-Tinbergen sense, which are valuable additions to the rapidly growing body of knowledge which deals with instinctive behavior.

In the second part of this book the author deals with the problem of "organic structuring." This he approaches by a geometric analysis of spider web construction. In discussing the experimental results the author touches on such topics as Gestalt, esthetics, innate or unlearned behavior, and the problems of form and function. A 4-page summary of the history of animal psychology and its problems completes the volume.

ECKHARD H. HESS

STUDIES ON THE STRUCTURE OF THE FISH SCHOOL. *Bull. Amer. Mus. Nat. Hist. Vol. 98, Art. 1.*

By C. M. Breder, Jr. American Museum of Natural History, New York. 50 cents (paper). 27 pp. + 4 pl.; text ill. 1951.

THE STUDY OF INSTINCT.

By N. Tinbergen. Oxford University Press, New York. $7.00. xii + 228 pp. + 2 pl.; text ill. 1952.

Tinbergen's book is a positive requirement for all students of behavior. It is a most refreshing and stimulating account of some of the important contributions European scholars have been making to the study of instincts, a field of behavior sorely neglected in American psychology today. In fact, Tinbergen considers this work sufficiently different from psychology and American behaviorism in its orientation and methodology to distinguish it by the term "ethology." Ethology is defined as the scientific study of behavior. It is aimed at determining the physiological basis of organisms' reactions to stimuli and their adaptation to the environment. As such, it is a broad field of study, overlapping psychology, physiology, ecology, sociology, taxonomy, genetics, and evolution, and perhaps contributing as much to these fields as it borrows from them.

At the current point in the development of ethology, the focus of attention is on the instinctive behavior pattern. The scientific problem is to determine (a) the stimuli which control innate behavior, (b) the internal conditions which "prime" the organism for particular patterns, and (c) the central neural mechanisms responsible for the integrations of the total sequence of behavior. In pursuit of these goals, Tinbergen says that the ethologist should know the genetic potentialities of any particular organism, understand its ontogenetic development, and compare it to members of other species.

Each of the problems addressed by the ethologist in the study of instincts is treated in detail in the 8 chapters. After a definition of ethology and a statement of its relation to other disciplines, Tinbergen takes up the reactions to external stimuli, the role of the internal environment, and the organization of the nervous system in the control of instinctive behavior. The last 3 chapters are on the adaptiveness of behavior the ontogenetic development of behavior, and the phylogenetic development of behavior.

In describing this work on instincts, Tinbergen offers a number of very important new facts and new concepts which should not be overlooked by American students of behavior. His major points can be summarized briefly.

1. Innate behavior patterns are set off most readily by particular stimuli, called *sign stimuli*. For example, the begging reactions of the herring gull chicks are tripped off by the red patch on the mother's bill. Experiments with dummies show that the red patch is the only feature of the mother's head which elicits the full reaction. Furthermore, the reactions become fewer and weaker if the patch is moved from its natural position at the end of the lower mandible.

2. Facts like these and others lead to the belief that instinctive behavior is controlled by an *innate releasing mechanism* (*IRM*) in the nervous system which is tripped off only by very particular kinds of stimulation.

3. In the activation of the IRM, there may be *heterogeneous summation* of different stimuli. Thus some

innate reactions set off by either form or color will be more easily elicited when the stimulus has both the appropriate form and the appropriate color.

4. Innate behavior often consists of *reaction chains*, each reaction with its own IRM and its own sign stimuli. Thus the honey-bee is first attracted to flowers by their color, but it will not alight unless it is stimulated by the right odor.

5. Stimuli serve to direct innate behavior as well as release it. Thus we have the various types of stimulus-controlled orientation, the various *taxes*.

6. The sign stimuli releasing innate reactions may often be the responses given by another individual of the same species. So Tinbergen includes a class of *social releasers* in his system.

7. The threshold for releasing innate reactions is determined by the internal environment of the organism. If the neural centers operating in instinctive behavior are sufficiently sensitized by the internal chemical condition produced by lack of food, hormones, etc., then the behavior may be set off by minimal stimuli or may occur "spontaneously." Such reactions in the absence of any obvious stimulation are called *vacuum reactions*.

8. There is an *hierarchical organization of the nervous system* in which there are various levels of integration of instinctive patterns. At each level, there are one or more neural centers, each blocked by an IRM. Each neural center is primed (a) by stimuli, (b) by internal chemical conditions, and (c) by discharges from other centers at the same or higher levels. The more these centers are primed, the more likely they are to break through the block set up by the IRM, but normally the block is removed by sign stimuli affecting the IRM. For example, in the reproductive behavior of certain fish, the theory holds that the tendency to migrate is integrated at the highest levels. The fish migrates until appropriate stimuli release instincts integrated at the next lowest level: nest building, fighting, etc. Then at the next level are integrated the consummatory acts of reproduction; and at still lower centers, the component responses that make up the final consummatory act.

There is no question but that Tinbergen's book is an important contribution to the study of behavior. As the author points out, ethology could ultimately be a complete science of behavior; but as it stands now, ethology's contribution is mainly restricted to instinctive patterns of behavior as they occur in the lower vertebrates and the invertebrates. The present book deals very little with the behavior of man and other mammals, instinctive or otherwise. And perhaps for this reason, Tinbergen has very little to say about learning, personality, or other complex behavior functions. In all fairness, however, it should be emphasized that ethology today represents only a start on an ambitious, but sound, scientific program of research in the field of behavior.

ELIOT STELLER

PARENTAL CARE AND ITS EVOLUTION IN BIRDS. *Ill. Biol. Monogr., Vol. XXII, Nos. 1–3.*

By S. Charles Kendeigh. The University of Illinois Press, Urbana. $4.00 (paper). x + 356 pp.; ill. 1952.

Kendeigh has made intensive studies of nesting birds over a period of several years at the Baldwin Bird Research Laboratory in Ohio. Some of his findings have already been published. The present volume reports on those aspects of the investigation that concern parental care, i.e., the relative roles taken by the sexes in nest building, incubation, and care of the young. The house wren (*Troglodytes aedon*) received chief attention, and about 80 pages are given to a very detailed and often tabular analysis of nesting behavior in this species. The wrens nested in man-made boxes especially designed for observation and for the introduction of thermocouples and other mechanical recording devices. The specifications and use of these devices is fully described and should be of great help to other scientists.

The second part of the study consists of a less detailed account of parental care in 19 other species of birds. Most of these were studied by Kendeigh and he also makes full use of the publications of others, such as the monograph of Mrs. M. M. Nice on the song sparrow (*Melospiza melodia*). Tables give the average length of periods on and off the nest during incubation, the number of times the young are fed per hour at various ages by each parent, etc. The concluding section of more than 100 pages the author calls the Evolution of Parental Care. Most of it comprises a description of parental care, so far as it is known, in all the families of the class Aves. This information, which has been compiled from the general literature of natural history, is much less detailed than that which is given for the species with which Kendeigh has worked himself. Such data are widely scattered in the literature, and complete coverage was hardly possible. Even so, some of the omissions are a bit surprising. It is difficult to believe, for example, that nothing is known of parental care in the family of guinea-fowl, when we recall that one of the species has been domesticated for centuries. Likewise, in the account of the hornbills (*Bucerotidae*), the ground hornbills (*Bucorvus*) are not mentioned. They would seem to be of crucial importance in the evolution of parental care in this family, for they are the only ones that do not have the specialized behavior in which the female is sealed into the nest cavity with mud and there fed by the male until the eggs hatch and the young are well grown.

The concluding pages discuss the evolution of parental care. It is logical to assume (and the incipient parental care in some snakes and crocodilians supports the belief) that the female originally took the main part in the care of eggs and young. Nevertheless, among living birds equal participation by the sexes is more common among the "lower" orders than in the more

"advanced" songbirds, where the female often assumes the entire burden of incubation. In many such species the male feeds his mate on the nest as she incubates and helps feed the young after they hatch. There are numerous specialized groups in which the male or the female, but not both, perform the entire duties of incubation and care of the young. In species with brood parasitism, which have evolved in several groups of which some of the cuckoos are best known, the entire care of eggs and young is foisted onto other species.

This is a valuable contribution, both for the very extensive new material presented and because it summarizes a vast number of scattered facts, all of which are analyzed from a comparative and evolutionary point of view.

DEAN AMADON

THE PRENATAL ORIGIN OF BEHAVIOR. *Porter Lectures, Series 18.*

By Davenport Hooker. University of Kansas Press, Lawrence. $2.50. viii + 143 pp.; ill. 1952.

The titles of the 3 lectures are: Fetal Activity in Infrahuman Vertebrates; The Sequence in Human Fetal Activity; and The Significance of Structural and Functional Interrelationships in Prenatal Activity. The lucid style in which the account of the genesis of man's overt behavior is written makes for fascinating reading. These lectures are in no way a popular treatise of man's early reactions, but deal accurately and forcefully with data accumulated in the last two decades in the Department of Anatomy of the Medical School, University of Pittsburgh. This study presents more cases than any other undertaken, and it must be said with greater control of all factors concerned.

The first chapter admirably presents in review what has been done in regard to fetal activity in those animals below man. The Coghillian concept of the total pattern of behavior is broadly outlined. Reflexes are not discrete units of activity knit together to form the total pattern of behavior, but emerge or individuate out of the over-all body activity. Other points of view are clearly presented and critically evaluated in the light of all work appearing in this exciting field of investigation.

Lecture II criticizes and deals with the technical problems involved in obtaining data on human fetal behavior and encountered by all workers. The sequence of events in human fetal behavior is then presented in bold relief. The movie camera catches all that the eye may have failed to detect. Hooker's analysis and interpretation of the human fetal movements fit the general Coghillian scheme. It is clearly shown that the human fetus responds as a unit, and the individual discrete reflexes individuate out of the total pattern of behavior. These studies on the physiological responses of human embryos and fetuses are an excellent beginning in human genetic neurology. From Aristotle on, all competent naturalists have expressed the necessity of understanding origins. Behavior is no exception. Prenatal behavior leads to an understanding of the basic fundamental patterning of adult activity so necessary in understanding human responses, individually and collectively.

Chapter III points up this significance in presenting the structural and functional interrelationships which have their beginning in the prenatal state. The nervous system is not dealt with alone. All systems are mentioned, especially the muscular and vascular systems. Most students in the fields of anatomy, physiology, psychiatry and psychology will profit considerably by a study of these three lectures.

The field of genetic neurology is in its infancy. The origin of behavior is a major division of this new frontier of science. Davenport Hooker, in bringing together the Pittsburgh studies, has rendered a great service in advancing our knowledge of the origins of man's overt behavior. The Kansas University Press has presented the material in a beautifully bound monograph.

PAUL G. ROOFE

CHILDHOOD EXPERIENCE AND PERSONAL DESTINY. *A Psychoanalytic Theory of Neurosis.*

By William V. Silverberg. Springer Publishing Company, New York. $4.50. xiv + 289 pp. 1952.

This is another book about children and the meaning of the various experiences to which infant flesh is heir. It is written by a man usually associated with adult patients, so that there is a strong flavor of the academic about this work. Though some of Silverberg's ideas are interesting, they suffer from being expressed so dogmatically that it is either irritating or misleading to read his volume.

HELEN ARTHUR

CRUELTY TO CHILDREN.

By Eustace Chesser. The Philosophical Library, New York. $3.75. 159 pp. 1951.

This is a short book written with earnest conviction and considerable common sense, but no profundity. Chesser sketches some of the factors that tend to increase the unpleasant problem of cruelty to children. These include low mentality of parents, instability of the home environment, over-burdened motherhood, broken homes, rejection of maternal instinct, poor education of young people for the role of parenthood, and the neuroses of our time. The author questions whether punishment per se is a solution in dealing with

parents who are cruel to their children. He advocates better legislation for protection of children, better education, pre-maritally, for young people, and a more enlightened social attitude toward children and their problems generally.

HELEN ARTHUR

OUR CHILDREN TODAY. *A Guide to their Needs from Infancy through Adolescence.*

Edited by Sidonie Matsner Gruenberg and the Staff of the Child Study Association of America; with an Introduction by Dorothy Canfield Fisher. The Viking Press, New York. $3.95. xviii + 366 pp. 1952.

This volume is a symposium of articles by a most impressive group of 26 well-known authors, educators, and psychiatrists. Mrs. Gruenberg, whose name has long been associated with her devoted work for the Child Study Association of America, has done a splendid job of organizing and coordinating this variety of material into a well-structured whole.

With contributors of such international standing as Anne Freud, Pearl Buck, Arnold Gesell, Alan Gregg, and David Levy (to mention a representative few) it may be taken for granted that concepts incorporated in the book are sound. The project seems designed to enlarge the reader's understanding of children as they develop in our world today and to present such readers with ways of thinking rather than dicta as to ways of doing. It is an excellent non-technical guide to sound principles of mental health for youngsters. It should be of interest to intelligent parents and teachers.

HELEN ARTHUR

(*The editor expresses his deep regret over the untimely death of Helen Arthur, who has reviewed so many books on child psychology and psychiatry for the Quarterly Review of Biology.*)

NEW CONCEPTS OF HYPNOSIS *as an Adjunct to Psychotherapy and Medicine.*

By Bernard G. Gindes; introduction by Robert M. Lindner. The Julian Press, New York. $4.00. xv + 262 pp. 1951.

At the beginning of the century, Pierre Janet wrote, "If my book be ignored today, it will be read tomorrow when there will have been a new turn of fashion's wheel, bringing back treatment by hypnotic suggestion just as it will bring back our grandmother's hats." During the past two decades, Janet's prediction that hypnosis would become an acceptable and effective therapeutic method has been realized. The present phase of the history of hypnotism closely resembles that which confronted Janet. There is a tendency to oversimplify clinical data, to make extravagant claims, and to insist that multiple sets of facts and gaps between sets of facts can be "explained away" by including them within a single postulation system.

Gindes' book presents no new concepts, and what is sound and clinically valid in the text has been known for many years. The author seems to be aware of this fact when he states, "One psychotherapeutic fact is certain, and we base all of our curative ability on this one premise, so aptly phrased by Dubois (1905): 'The patient with a functional malady will get well when he is convinced that he will be well; he will be cured at the exact moment that he convinces himself that he is cured.' "

The author also agrees with Bernheim's statement that "suggestion" is the governing principle behind all hypnotic manifestations and considers the "fundamental axiom" to be that suggestion creates the hypnotic phenomena and the phenomena create heightened suggestion. In accordance with this principle, everyone is suggestible, if one becomes more suggestible. That is hypnosis. Gindes properly states that the patient "hypnotizes himself"—a clinical observation that was made in 1825 by the founder of the theory of suggestion, Alexandre Bertrand.

Beginning with the statement that "Imagination and belief are basic in any technique," the author advises the beginner to "unalterably follow specific rules."

"1. He must give the impression of authority,
2. He must enlist the confidence of the subject.
3. He must prepare, word for word and action for action, everything he is going to say or do in order to avoid hesitancy in the presentation.
4. He must develop the proper use of his voice that it may be at once comforting and dynamic. This combination is rarely found in nature. It requires vocal training under proper guidance, but it can and must be acquired for consistent success.
5. The surroundings must tend to conduce a rapport between patient and therapist. The stage must be set with the care and precision of a theatrical technician.
6. The therapist's person must carry prestige."

The above sounds more like a planned theatrical presentation with a memorized script and a rigid set of stage directions than a spontaneous interpersonal relatedness which develops between the one who comes for help and the selected helper. In other parts of the text, the author emphasizes that the method has to be individualized in keeping with the therapeutic needs as they arise and the personality of the patient. In my own experience, no amount of preparation or "vocal training" or "proper" surroundings can replace the physician's sincerity and ingenuity in utilizing every therapeutic opportunity in the interest of the patient.

The author's approach to psychosomatic problems is inclined to be somewhat naive. The somatic problems are minimized and psychological influences are overly exaggerated as being the major, if not the only, factor. Thus in one example, Mrs. J. is worried because her

daughter "is growing away from her maternal solicitude, has an argument with the girl and shortly thereafter, falls down the steps breaking a leg. Emotional upset during her convalescence leads to a tooth infection that requires total extraction and dentures. While waiting for the dentures, her mingled rage and frustration produce glandular imbalance and 'gall trouble' results. Worry over the 'gall trouble' intensifies it to the point where an operation is necessary." The daughter "who was just as angry, batted balls around the tennis court, got the 'rage' out of her system, and 'luckily,' escaped the dire consequences of the argument."

I would also question the validity of the profound insights into human nature which "depth hypnosis" reveals. In a "case of impotency," the patient was instructed to look at a screen and to "see" a picture of his father. The patient saw himself as if he were 4 years old, said that he didn't know where Dad was, and saw himself lying in his mother's arms; she was doing something "bad" but he was enjoying it. The patient then spoke of wanting to kill his mother. "She made me think things that I wasn't supposed to think. Now I know exactly and I can't help myself. I must hate her for that." Finally he was persuaded to reveal what his mother had said, which was, "When you are older, I'll tell you exactly what you're supposed to do with this. But until then no one is supposed to touch you there." The patient became "violent with rage," and only after 5 sessions was "desensitized" and could agree that the mother "was only unfortunate in her ignorance and should perhaps have been psychoanalyzed also. . . . As soon as he accepted this realization, the symptoms of impotence disappeared completely." In evaluating the significant factors, no consideration was given to the possibility that the patient had "accepted this realization" because it helped him to deny any responsibility for what he himself had contributed toward the development of his impotence and that he had used his mother as a "scapegoat" when he said, "I can't help myself. I must *hate* her." This type of "therapy" becomes a folie à deux, the therapist always "agreeing" with the patient that basic personal inadequacies need not be touched upon since all that matters lies in the remote past, is buried in the "depths," and is to be blamed upon someone else.

Throughout the book there are numerous examples of the author's technical skill and ingenuity in "setting the stage" so that the patient can go on to develop the trance state. Thus when there is "resistance," the author casually lifts the patient's eyelid and authoritatively remarks that from all indications he can see no reason why the patient should not respond to hypnosis. "This is generally the turning point and will insure success. . . ."

Gindes is in accord with Hollander that "with adequate conditioning criminal acts can be facilitated through the use of hypnosis;" the contrary opinion by Erickson is not cited.

In the brief historical chapter, Mesmer is dismissed as a charlatan and a quack. The facts are otherwise. At a time when nothing was more dreaded than ridicule, Mesmer defended his thesis against the mechanical rationalism of his confrères; in an "ultra-enlightened age" when physicians were not interested in treating poor patients, Mesmer increased his unpopularity by admitting them to his clinic; and he refused Marie Antoinette's offer of an annual income of 40,000 livres to remain in Paris, preferring the approval of The Academy.

The chapters dealing with objective and subjective methods of hypnotic induction are well written, although there is considerable doubt whether such a dichotomy is of clinical value. The book offers a number of helpful hints to anyone who is interested in learning the technical aspects of hypnosis. Gindes repeatedly admonishes that the welfare of the patient comes first. ("When a subject submits completely to the dictates of the therapist he does so with confidence and trust. These qualities must never be violated, even in jest.") There is an adequate bibliography at the end of each chapter, and an appendix with 3 detailed case studies, but no index is included.

In short, I regret that I cannot agree with the enthusiastic Introduction, which characterizes the book as being "a sober and balanced survey of the uses and range of a powerful instrument." The style of the book would indicate that an attempt was made to please both the non-professional as well as the professional reader. The result is that it cannot be used as a textbook or as a non-technical summary of hypnotherapy.

JACOB H. CONN

THE EGO AND THE SELF.

By Percival M. Symonds. Appleton-Century-Crofts, New York. $2.50. xii + 229 pp. 1951.

This small but extremely clarifying book is a reminder to those who work with the mentally and emotionally ill that the psychic elements that make up illness do not differ in kind from those that constitute health. Aside from demonstrable congenital impairments and accidents, such as brain injuries, which produce illness, it is Symonds' thesis that mental-emotional illness is mismanagement by the ego of the relations between instinctual drives and the environment; and that conversely, mental-emotional health results when the ego "mediates rationally and constructively between the inner needs of the organism and the outer environment."

What then is the ego? The ego is a process of reaction which has three distinct elements: perceiving, thinking, and acting. "Man is not born with an ego; but the ego is the product of learning and development." The chapter on the Development of The Ego is a vivid

and lucid description of how learning germinates from organic needs and then grows more complex as a function of developmental experience. What then determines whether the ego (the perceptive, thinking, and acting capacities) becomes strong and efficient or the opposite? Here Symonds introduces the idea of "self," the subjective "I." If positive self-evaluations of the child are developed and nourished by the parents, ego growth proceeds along healthy lines; but with "too much frustration and too little satisfaction, however, ego growth is retarded and reality is actually denied, for the pain is more than can be borne."

To me the concept of the "self" as enunciated by the author seems to be one and the same as the super-ego. In Symond's own words, "the fact that concepts of 'self' are a reflection of the attitudes expressed toward a person by others" constitutes an admission by the author that this is the case. The introduction of this new terminology is thus confusing; and for purposes of clarity the use of the term "super-ego" throughout would have served better.

Symonds' treatment throughout his book of psychic elements such as anxiety, repression, ambivalence, projection, identification, rationalization, fantasy, etc., is constructive and illuminating. Thus he demonstrates that these are and can be tools of the normal development and integration of the efficient ego when accompanied by a permissive and accepting super-ego. When, however, the super-ego is frustrating and tyrannical, these psychic implements impair, split, weaken, and even destroy the ego. On the other hand, a confusing, weak, or distorted super-ego permits the instinctual drives to break through; or else represses the instinctual drives excessively so that the resulting great anxiety and tension also impair, split, weaken, and even destroy the ego.

For those engaged in the study and treatment of the mentally and emotionally ill, the chapters entitled The Role of The Ego in Pathological States and The Place of The Ego and The Self In Psychotherapy, while very brief, should be particularly helpful. Therapy is interpreted as basically a bolstering of the ego through permissive and accepting support; in other words, an effort to change the ego structure by the supportive incorporation of unconscious and unacceptable contents that have been withheld through the intervention of a weak, distorted, or tyrannical super-ego.

While *The Ego and The Self* is most interesting to me from a psychiatric point of view, the book could and should be used as a basic textbook by the student and practitioner of child psychology as well as the social worker. The material in this book which deals with the development of perception, thinking, acting, and feeling is especially meritorious and deserves the closest study. If, as Symonds says, "ego strength is the efficiency of the ego in regulating impulses and mastering the environment," it behooves all of us—educator, psychologist, social worker, and psychiatrist—to discover what builds ego strength; and if weakened or impaired, the methods whereby ego strength may be rebuilt or recovered.

DAVID ROSS

HUMAN BIOLOGY

CHILDHOOD AND SOCIETY.
By Erik H. Erikson. W. W. Norton & Company, New York. $4.75. 397 pp. 1951.

Erikson, a skilled child psychoanalyst and a man of wide sociological experience, has written this book dedicated "to our children's children." It is a fitting dedication, for the concepts which Erikson presents are so far-reaching in their implications that their full impact on our way of thinking and dealing with children in our society can only reach maturity over several generations.

In Part One, Erikson in an easy but explicit fashion considers the diffuse topic of Childhood and the Modalities of Social Life. He shows, using case histories, how a variety of pressures, internal and external, from family relationships and society, impinge on a patient to cause emotional upsets. Having established this broad base, the author goes into a detailed account of The Theory of Infantile Sexuality. He makes the Freudian concept of the dynamic psychological development of children not only clear but reasonable. From here, with the keynotes of his thinking carefully recorded, he shows how cultural demands within different societies come to be and how they shape, with a deep underlying cultural purpose, the psychological development of the individuals who are reared in that particular society. In a fascinating and thrilling narrative style, he presents an anthropological and psychoanalytic survey of the contrasting Sioux Indians of South Dakota and the Yurok Indians of the Pacific Coast.

In Part Three, the author takes up The Growth of the Ego as a development within the growing child. Then, in an extremely thought-provoking chapter, he describes how this growing ego must relate itself at different stages on the road to maturity, to the society in which it is reared. As a result of this total experience a kind of National Character or identity is achieved within the society.

In Part Four, Erikson discourses of the kind of person who is developed by the cultural pressures and myths in American society. From the legend of Hitler's youth, he deduces the factors that make up the German identity, and applying his psychoanalytic and anthropological insight to the understanding of an early Russian film on the childhood of Maxim Gorky, he makes some assumptions about underlying factors in Russian character development.

In order to understand ourselves, what kind of people

our children are going to be, and the motivations inherent in people belonging to other societies, we must learn to think in the over-all pattern Erikson so fluently presents. If there is any way to change the shape of our own national identity so it will be a more appropriate structure for our highly technical age, we must be aware of the unconscious pressures from previous ages that impinge atavistically on our modern life.

This is an important book. Everyone who is interested in children should read it. Everyone who is interested in nations as the aggregate of the people who make them, should also read it.

HELEN ARTHUR

BIOMETRY

STATISTICS FOR MEDICAL STUDENTS AND INVESTIGATORS IN THE CLINICAL AND BIOLOGICAL SCIENCES.

By Frederick J. Moore, Frank B. Cramer, and Robert G. Knowles. The Blakiston Company, Philadelphia and New York. $3.25. viii + 113 pp.; ill. 1951.

The purpose of this small book is, in the words of the authors, "more concerned with providing a grasp of the fundamental concepts and philosophies than with developing technical facility in the application of statistical methods." In so far as a realization of this goal is possible at the elementary, non-mathematical level, the book appears to fulfill its intended purpose. Designed primarily for the student and worker in the fields of biology and medicine, the treatment is introductory in nature, although considerable coverage is made at the general level of the various areas of statistics. The mathematical treatment is limited to concise algebraic formulations with text descriptions that tend to convey the essential idea behind the technique illustrated. One possible drawback to the use of this book by some medical students is its extreme brevity. However, used in conjunction with lectures or laboratory exercises designed to supplement the examples contained in the text, this book should afford an excellent introduction to statistical procedures and theory for the student non-mathematical in inclination.

VERL L. HOUSE

ELEMENTARY MEDICAL STATISTICS. *The Principles of Quantitative Medicine.*

By Donald Mainland. W. B. Saunders Company, Philadelphia and London. $5.00. ix + 327 pp. + folding diagram; ill. 1952.

The teaching of statistics to medical students has the reputation of being a difficult and even painful chore. *Elementary Medical Statistics*, by Donald Mainland, will greatly lighten this task. Here is a textbook aimed at the medical student—the man who will someday be a practicing physician—and which hits the target squarely.

Mainland wisely limits the methodology to 4 topics, confidence intervals and significance tests for percentages and means. These 4 topics are presented in great detail, with emphasis on where the methods are appropriate and how they may be interpreted. A desirable feature of this book is that it does not try to present too much material. The purposes and use of numerous statistical methodologies are mentioned, but not elaborated (curve fitting, regression, analysis of variance, life tables, vital statistics, etc.). Although a more detailed discussion of some of these topics might be valuable to some students, it will generally be better to leave the student with a few well understood ideas rather than a confused jumble of statistical devices.

Special emphasis is laid on the principles and logic of medical experimentation and on the weaknesses and pitfalls of clinical studies. Although the author's explanations are unusually clear, he sometimes gets tangled up on his definitions. For example, he defines bias as "something that makes a sample different from what it seems or purports to be." One of three definitions of a random sample is "a sample chosen according to a rule that is completely independent of the observations." A student might have difficulty in understanding why this definition would not include systematic samples, viz., such a rule as "select every tenth person on a list."

In view of the price and the heavy usage which such a book will get, it seems regrettable that the publisher should have used a paper cover rather than a hard cloth cover.

I. BROSS

THE DESIGN AND ANALYSIS OF EXPERIMENTS.

By Oscar Kempthorne. John Wiley & Sons, New York; Chapman & Hall, London. $8.50. xix + 631 pp. 1952.

Several good books on the design and analysis of experiments have been published within the past few years, and Kempthorne's should be added to the list. In content, Kempthorne's textbook most nearly resembles Cochran and Cox's *Experimental Designs*. Although Kempthorne has a somewhat broader and more general point of view (he has chapters on the theory of least squares, on the general linear hypothesis, and on some other general topics); the reader will be more impressed by the similarities in content of the two books than by the differences. Both books, for example, discuss completely-randomized, randomized block, Latin square, Graeco-Latin square, and factorial designs. Both also deal with confounding, plot techniques, lattice squares, and the analysis of groups of experiments.

The principal difference between Kempthorne and Cochran and Cox is the way the two books develop their material. Cochran and Cox admit frankly that they wrote a handbook for experimenters, to be consulted when a new experiment is planned. For this reason, illustrative examples and computational details have been kept to a minimum. Kempthorne, on the other hand, has written a textbook. He treats the subject matter in a more consistent manner and he has supplied more details in dealing with illustrative problems. This does not mean that Kempthorne is simple reading. On the contrary, he assumes that the student has already had a course in statistics (Chapter 3, for example, on Elementary Statistical Notions, discusses the normal, chi-square, t, F, binomial, and Poisson distributions in six pages!).

To sum up, Kempthorne's book has about the same content as that by Cochran and Cox. Both are good books, on a high level, and your choice of one or the other will depend upon your preferences in the treatment of this subject matter.

A. CHAPANIS

NOMOGRAPHY AND EMPIRICAL EQUATIONS.

By Lee H. Johnson. John Wiley & Sons, New York; Chapman and Hall, London. $3.75. x + 150 pp. + 2 folding scales; text ill. 1952.

Scientists, businessmen, and other professional people who collect quantitative experimental and operational data, frequently have the problem of presenting these data in meaningful and useful ways. Johnson's book has as its purpose the explanation of two useful techniques for handling such data, namely, nomographs, which provide quick graphical answers whenever numerical data can be substituted into formulas, and empirical equations, which are the mathematical expressions of data plotted in the form of curves.

The first half of Johnson's book is devoted to nomography. In it he discusses the construction of uniform, logarithmic, and other scales, parallel scale nomographs, Z-charts, parallel and perpendicular index lines, concurrent scales, recurrent variable nomographs, and combined nomographs for equations involving up to six variables. The second half of the book, labeled Empirical Equations, deals essentially with curve-fitting problems. Here the author discusses tests for determining the type of equation which will best fit empirical data, and techniques for fitting empirical equations to the data. Linear, parabolic, exponential, and hyperbolic equations involving two or three constants; and certain special equations involving four constants are considered.

Mathematical and statistical experts will find serious omissions in the book—for example, there is no discussion of tests of significance as applied to curve-fitting problems, there is no mention of the exact least-squares solution for parabolic equations, the Gaussian and Poisson distribution functions are missing, and so on. It is apparent, however, that Johnson intended this to be an elementary book for readers with little mathematical sophistication. The book starts, for example, with a very clear and simple discussion of the differences between linear and logarithmic scales, and the rest of the book makes use of mathematics no more involved than geometry and simple algebra. Other features of the presentation are equally clear and well done. Despite its gaps, this should be a worthwhile and practical textbook for biological scientists who want a simple, lucid introduction to methods of handling quantitative data by nomography and empirical equations.

A. CHAPANIS

DE OMNIBUS REBUS ET QUIBUSDAM ALIIS

A NEW SURVEY OF SCIENCE. *A Revised and Enlarged Edition of Science Marches On.*

By Walter Shepherd. Harcourt, Brace & Company, New York (printed in Great Britain). $4.75. 512 pp. + 35 pl.; text ill. 1950.

This is a revision of an early survey called *Science Marches On* (published in 1939), of which the author stated that "... the main object has been to show the origin and trends of man's ideas about the universe in which he lives," expressed through "... an attempt to present science *whole*, particular discoveries being cited more by the way of illustration than for their own sakes." This approach is very appealing and serves well to counter the too prevalent technic of presenting the pattern of the history of science as consisting of isolated stepping-stones of individual contributions, of progress pegged to individual efforts. The mission which Shepherd set himself is vastly more difficult than leaping from hero to hero (or rogue) of science. With judicious selection and fine balance of proportion, and with the talent of a skilled narrator, the author has succeeded in accomplishing his task. In 21 chapters, the whole of the story has been sketched —in broad lines, but not without some fine etchings. The last chapter, Where is Science Going? will provoke much controversy. However, just as the meaning and usefulness of a college "survey course" depends as much, if not more, upon the listener than the lecturer, so I feel of Shepherd's work. The better and broader the scientific knowledge of the reader, the better will be his appreciation of the progress in understanding man and nature as presented by the author. The list of names and places is formidable, yet the continuity is of the ideas, not the actions, of men. It is a book worth reading—if one is a reader of "surveys." The

printing is good, the simple line drawings illustrative, and the index extensive.

M. C. SHELESNYAK

SCIENCE NEWS 26.

Edited by A. W. Haslett. Penguin Books, Melbourne, London, and Baltimore. 50 cents. 128 pp. + 16 pls.; text ill. 1952.

Contents of biological interest: The Norwegian-British-Swedish Antarctic Expedition 1949–52 (E. F. Roots); A New Era in Microscopy (J. G. Thomas); Ion Exchange (K. S. Spiegler); Philosophical Analysis and Scientific Progress (John E. Owen); Research Report: Fluorescence of Teeth, Concentration of Trace Elements by Seaweeds, Sandhopper's Compass, Virus Diseases of Fruit Trees (A. W. Haslett).

THEORETICAL NUCLEAR PHYSICS.

By John M. Blatt and Victor F. Weisskopf. John Wiley & Sons, New York. $12.50. xiv + 864 pp.; ill. 1952.

SPACE-TIME STRUCTURE.

By Erwin Schrödinger. Cambridge University Press, New York and London. $2.75. viii + 119 pp. 1950.

FREEZING AND DRYING. *Report of a Symposium held in June, 1951.*

Edited by R. J. C. Harris. Hafner Publishing Company, New York. $3.00 (paper). 206 pp.; ill. 1952.

This is an account of the Proceedings of the First International Symposium on Freezing and Drying. From the list of titles of the various sessions the coverage is quite comprehensive: industrial applications including the design of equipment, the preservation of mammalian cells at low temperatures, the freeze-drying of bacteria and viruses, and tissue fixation by freezing and drying.

ISIDORE GERSH

THE BEST SCIENCE FICTION STORIES, 1952.

Edited and with an Introduction by Everett F. Bleiler and T. E. Dikty. Frederick Fell, New York. $2.95. 288 pp. 1952.

This is a fine collection of science fiction stories that will appeal to both novice and fan. The newcomer should not attempt to wade through the introduction, which is, for the most part, absolutely silly. The science fiction fan can probably take such stuff in stride, but the innocent dabbler is likely to be frightened off. The stories appeared during 1951 in the popular science fiction magazines and represent the efforts of a number of the better-known writers.

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